COPPER.

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BY CHARLES KIRCHHOFF

Since the census year 1880 the United States has risen to the rank of the largest copper producer in the world, outstripping by far any other country. During the decade Arizona and, later, Montana have become important producing states, the latter having acquired and now maintaining rank as the leader. While by far the greater part of the metal produced is obtained from ores carrying only the baser metal, important quantities in the aggregate are derived from ores in which lead, gold, and silver are the principal constituents of value. These quantities are difficult to trace to their source. The ores are purchased by lead and copper smelters in the open market, often in small parcels, indirectly, through sampling works. Sometimes copper is not even present in the original ore in marketable quantity, and becomes a factor only when it appears in a concentrated form in the mattes of lead smelters and refiners.

The copper product of the United States in the calendar year 1889 was as follows:

	POUNDS.
Arizona	31,586,185
Michigan	87,455,675
Montana	98,222,444
New Mexico	3,686,137
Colorado	1,170,053
Idaho	156,490
Nevada	26,420
Utah	65,467
California	151,505
Wyoming	100,000
Vermont	72,000
Southern states	18,144
Lead smelters and refiners	3,345,442
Total	226,055,962

These figures include the quantities of copper reported as an incidental constituent of other ores.

COPPER MINING IN THE PRINCIPAL PRODUCING STATES IN 1889.

The details of the copper mining of the principal producing states during the year 1889 are given in the following tables, not including those mines fairly to be considered as precious metal mines:

PRODUCTION.

STATES AND TERRITORIES.	Ore produced. (Short tons.)	Mineral. (Pounds.)	Black copper. (Pounds.)	Matte. (Pounds.)	Fine copper contents. (Pounds.)
Total	3,322,742	117,804,926	39,713,237	159,547,390	220,569,438
Michigan	2,433,733	117,804,926	.....	.....	87,455,675
Montana	698,837	.....	10,176,744	147,800,590	97,868,064
Arizona	155,586	.....	29,532,493	4,126,000	31,362,685
New Mexico	34,586	.....	4,000	7,620,800	a3,883,014

a The apparent discrepancy between this amount and the amount entered in the above table of copper product is due to the fact that there is included in the larger amount the copper contents of ore produced by mines having no reduction works and no means of shipment of ore to market.

EXPENDITURES IN MINING.

STATES AND TERRITORIES.	Total expenditures.	Total wages.	Salaries.	Paid contractors.	Materials and supplies.	Taxes, rent, etc.	Office force.
Total	$12,062,180	$6,096,025	$120,896	$334,448	$4,067,970	$1,442,846	70
Michigan	7,478,828	3,174,363	67,369	306,627	2,682,491	1,247,978	41
Montana	3,204,455	2,010,940	22,515	2,722	1,029,990	138,288	10
Arizona	1,146,819	726,021	23,762	23,774	325,020	48,242	14
New Mexico	232,078	184,701	7,250	1,320	30,469	8,338	5

NUMBER OF EMPLOYÉS.

ABOVE GROUND.

STATES AND TERRITORIES.	NUMBER EMPLOYED.				AVERAGE DAILY WAGES.				AVERAGE NUMBER OF DAYS EMPLOYED.			
	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.
Total	84	741	1,718	20	$5.28	$2.88	$1.91	$0.88	305	304	297	304
Michigan	63	547	1,247	15	5.31	2.30	1.58	0.75	313	311	301	303
Montana	7	131	162	.....	4.86	4.76	3.13	.....	289	300	274	.....
Arizona	11	57	252	5	5.43	3.97	2.63	1.25	276	260	286	305
New Mexico	3	6	57	.....	5.00	3.75	2.50	.....	269	221	314	.....

BELOW GROUND.

Total	114	4,236	1,725	83	4.43	2.71	1.74	0.95	299	298	306	308
Michigan	57	2,101	1,582	83	4.04	1.99	1.67	0.95	312	314	307	308
Montana	30	1,609	9	.....	4.93	3.53	3.00	.....	300	281	129	.....
Arizona	23	408	82	.....	4.89	3.19	2.62	.....	274	290	308	.....
New Mexico	4	118	52	.....	3.71	2.58	2.25	.....	259	274	293	.....

CAPITAL INVESTED.

STATES AND TERRITORIES.	Total.	Land.	Buildings.	Tools.	Cash.
Total	$62,623,228	$50,113,325	$5,817,680	$3,386,588	$3,305,635
Michigan	33,111,253	22,333,442	5,449,271	2,272,622	3,055,918
Montana	23,395,000	22,375,000	223,000	797,000	.....
Arizona	5,490,050	4,960,383	33,409	247,791	248,467
New Mexico	626,925	444,500	112,000	69,175	1,250

POWER USED.

STATES AND TERRITORIES.	Animals.	Boilers.	Horse power.	Engines.
Total	305	226	34,390	265
Michigan	191	141	29,545	151
Montana	29	52	3,530	82
Arizona	66	21	775	25
New Mexico	19	12	540	7

LAKE SUPERIOR DISTRICT.

From an industrial point of view the conditions under which the Lake Superior copper-mining companies work are unique. The occurrence of the metal in the native state created problems for the solution of which experience in older mining regions could furnish no guide. Untrammeled by conventional methods, they have been attacked in a characteristically American manner. After an experience extending over a generation it may well be claimed that the practice of the majority of the mines is entitled to the claim of ranking with the best in this country. By systematic mining, by the liberal introduction of power drills, by the cheap handling of large quantities of rock, and by the development of crushing apparatus of great power well adapted to the special requirements it has become possible in the Lake Superior district to profitably extract copper from very low-grade rock.

While the district possesses certain great advantages, it is unquestionably hampered by drawbacks. The metal exists in the rock in the native state. The ore needs only to be crushed and washed to leave behind a product called "mineral", consisting of metallic copper. From the fact that the product of 117,804,926 pounds of mineral yielded 87,455,675 pounds of ingot it follows that the average percentage of copper is 74.24; but, on the other hand, the amount of native copper in the rock is small in the majority of cases. The total amount of ore hoisted to the surface, not including the few small mines worked by tributers and one of the larger mines, was 2,363,733 short tons. This yielded 86,604,283 pounds of ingot. The average yield of the principal mines was only 1.83 per cent of ingot. Excluding, however, the 2 phenomenally rich mines, the Calumet and Hecla and the Tamarack, the others produced from 1,369,180 tons of rock 27,330,536 pounds of ingot, so that the yield was 0.998, or almost 1 per cent of ingot copper. It follows, therefore, that a large tonnage must be hoisted to produce a moderate amount of copper. This, in turn, means very extensive underground development and a large investment in plant and

machinery for power drills, hoisting, crushing, and washing. Since the latter requires a large quantity of water, stamp mills have been located where it is most readily available and where the enormous quantity of sand can be readily disposed of. The result is that the transportation of the rock from the mine to the mill becomes an additional problem.

These conditions impose upon the Lake Superior copper companies a conservative policy, and rob them to some extent of the ability to quickly adapt themselves to rapid fluctuations in the demand and supply. They can not at short notice respond to calls for increased product, because preparations for an extension of operations involve the expenditure of large sums, extended underground development, and large additions to plant and equipment, with the long time which the execution of such plans requires. They are similarly hampered in any plans for an adjustment to the conditions which an overstocked market imposes. Low costs are based, in operations involving the handling of large quantities of rock, upon the full employment of equipment and force. Any curtailment means an undue burden of operating expenses and fixed charges upon a diminished product, while total suspension of operations presents the alternative of either providing for a steady outlay for the maintenance of mine and plant or ultimately, upon resumption, of paying a far larger aggregate sum as a penalty for neglect. It is natural, therefore, that, consciously or not, the managers of the Lake Superior copper companies have usually followed a conservative course.

Another result, which is the outgrowth of the conditions under which the mines must be worked, is the full employment given to labor in the district. This is well illustrated in the figures for labor and wages. With the exception of 1 mine, which was closed down for 50 days on account of the low price of copper, every company ranking as a regular producer has given full employment all the year round, Sundays and legal holidays being the only days of rest, to which must be added the respective holidays of the different nationalities represented. The total wages paid in the mining of copper rock at Lake Superior below and above ground were $3,174,363, including the estimated earnings of tributers at 4 mines, which have been placed at less than $8,000. 2 mines were developed during the census year. The companies which hoisted 2,363,733 tons of rock and produced 86,604,283 pounds of ingot paid in wages $3,004,621, so that the labor cost per ton of rock hoisted was $1.27, while it amounted to 3.47 cents per pound of ingot. It was the lowest in the case of the Atlantic mine, whose labor cost was only 67 cents per ton of rock hoisted. It should be noted that probably an even better expression of the labor cost of mining would be furnished by taking as the basis the tonnage of rock mined, some of the companies rejecting a varying quantity of rock underground. The total cost of mining rock which finally yielded 87,455,675 pounds of ingot copper was as follows:

COST OF MINING COPPER-BEARING ROCK IN THE LAKE SUPERIOR DISTRICT.

Wages	$3,174,363
Salaries	67,369
Paid contractors	306,627
Materials and supplies	2,682,491
Taxes, rent, and other outlays	1,247,978
Total	7,478,828

STAMP MILLS.

Reports from 11 stamp mills connected with or working for mines which hoisted 2,363,733 tons of rock show that 2,137,653 tons were crushed, producing mineral yielding 86,604,283 pounds of ingot copper. The difference in the tonnage treated is due principally to the fact that many companies find it necessary to reject in the rock houses a part of the material hoisted as too poor to go to the stamp mill. To some extent also a difference in the quantity of rock in stock at the stamp mill of at least 1 company in the beginning and at the end of the year accounts for the difference.

Like the mines, the stamp mills are operated during the entire year, with stoppages only during Sundays and holidays, so that the men are fully employed. The total wages paid in stamp mills were $514,756.79, so that the labor cost of stamping and washing per ton of rock hoisted averaged 21.8 cents, and per ton crushed 24.08 cents, while it amounted to 0.59 cent per pound of ingot. The number of men employed, their average wages, the maximum and minimum, and the average number of days worked are given in the following table:

EMPLOYÉS AT LAKE SUPERIOR COPPER STAMP MILLS.

CLASSES.	Number.	Average daily wages.	Maximum	Minimum.	Average number of days employed.
Foremen	19	$3.68	$4.85	$2.83	.....
Mechanics	128	2.17	2.75	1.80	317
Laborers	795	1.52	1.75	1.12	307
Boys	87	0.91	1.10	0.61	307

The stamp mills report expenditures for supplies of $570,724.33 (it should be noted, however, that in several instances no accurate separation between mine and mill supplies could be made); expenditures for salaries were $2,340; there was paid to contractors $2,618.71, and for insurance, rent, etc., $2,935.99, while the proportion of the taxes, rent, and other outlays to be credited to the stamp mills is estimated at $406,976.08, a total of $985,595.11. The outlays for salaries, taxes, insurance, etc., are, however, credited in total to the mining account, a separation being possible only in a very few instances.

MONTANA.

The product of those mines in Montana which may be classed as copper mines was 97,868,064 pounds of fine copper produced from 698,837 tons of rock, thus showing that the yield was 7 per cent.

The total expenditures involved in mining were as follows:

EXPENDITURES IN COPPER MINING IN MONTANA.

Wages	$2,010,940
Salaries	22,515
Paid contractors	2,722
Materials and supplies	1,029,990
Taxes, rents, and other outlays	138,288
Total	3,204,455

Concerning the smelting and concentrating operations the following data may be presented. It will be observed that the cost of operating this plant is nearly double that of the mining operations proper.

RESULTS OF SMELTING AND CONCENTRATING MONTANA COPPER ORES.

	POUNDS.
Matte	156,400,590
Blister	10,176,744
Fine copper contents, copper	102,188,716

LABOR AND WAGES.

CLASSES.	Number.	Average daily wages.	Average number of days employed.
Foremen	90	$5.00	355
Mechanics	139	4.08	351
Laborers	1,789	2.91	324
Boys	20	1.75	365

EXPENDITURES.

Total wages paid	$2,128,569.89
Salaries (24 persons)	50,493.75
Paid contractors	30,106.45
Supplies and materials	3,901,551.05
Rent, interest, insurance, taxes, etc	186,817.45
Total	6,297,538.59

It will be observed from the statement of wages paid that, generally speaking, they are nearly double those paid in the Lake Superior district, but that per ton of product they are considerably less, owing to the higher grade of the ore mined. With the exception, however, of the bessemerized copper produced by the Parrot company, the product must be first concentrated and subsequently smelted for matte, which is sold to American and foreign refiners.

A part of the product of one establishment was sold to another in the same district. The capital investment of all the mines is not reported, but it may be stated that the works produced in all 108,261,092 pounds of matte, containing 66,130,647 pounds of fine copper, and had invested in buildings and fixtures $2,195,000, in tools, implements, and machinery, $5,425,700, and in cash, $240,000. The number of animals employed was 29, and the plant included 52 boilers, of 3,530 horse power, 5 steam stamps with 250 horse power, and 82 engines.

The product of the concentrating and smelting operations is matte. The cost of transportation to market and the cost for refining must be added. Some of the companies, however, as an offset, draw a considerable revenue from the silver contents of the matte produced. This must be taken into account when dealing with the ability of the mines to compete in the world's markets.

ARIZONA.

The principal advantage of the Arizona mines as competitors in the copper market lies in the fact that the ores are relatively rich, yielding in 1889 a fraction over 10 per cent, and are easily reduced to black copper, being almost exclusively oxidized ores. The expenditures incurred in producing ore which yielded 31,362,685 pounds of fine copper were as follows:

EXPENDITURES AT COPPER MINES.

Wages	$726,021
Office force (14 persons)	23,762
Paid contractors	23,774
Supplies and materials	325,020
Taxes, rent, etc	48,242
Total	1,146,819

The smelting and concentrating of the ores involved the following expenditures and employed the following force:

LABOR AND WAGES AT COPPER-SMELTING WORKS.

CLASSES.	Number.	Average daily wages.	Average number of days employed.
Foremen	14	$5.34	281
Mechanics	21	4.13	274
Laborers	370	2.87	306

EXPENDITURES.

Wages	$345,787.11
Office force (10 persons)	22,998.00
Paid contractors	26,686.65
Supplies and materials	816,243.70
Rent, interest, taxes, etc	46,177.41
Total	1,257,892.87

POWER.

Animals employed	5
Steam boilers:	
Number	9
Horse power	790
Steam engines	8

CAPITAL.

Buildings and fixtures	$176,016
Tools, implements, and machinery	280,200
Cash	7,000
Total	463,216

STATISTICS OF COPPER REFINING IN THE UNITED STATES.

Only a part of the furnace material produced in the United States, a small quantity of ore, and nearly all of the mineral from the Lake stamp mills are refined in works the majority of which are controlled by firms and corporations not directly connected with the mines. In some works copper refining is incidental to the working of other base and precious metals, and in others it is a part of a general chemical business. One concern has failed to report. Returns cover establishments which produced 159,693,252 pounds of refined copper, valued at $19,686,561.86. The following are the data relating to them:

CAPITAL.

Lands	$634,000
Buildings and fixtures	1,758,856
Tools, implements, etc	600,214
Cash, etc	1,044,523
Total	4,037,593

LABOR AND WAGES.

CLASSES.	Number.	Average daily wages.	Average number of days employed.
Foremen	70	$3.59	314
Mechanics	334	2.68	307
Laborers	911	1.57	304
Boys	9	0.78	313

EXPENDITURES.

Wages	$800,484
Salaries (43 persons)	71,720
Paid contractors	19,591
Supplies and materials	737,098
Rent, interest, insurance, taxes, etc	256,368
Total	1,885,261

POWER.

Animals	37
Steam boilers:	
Number	28
Horse power	2,152
Steam engines	30

It is interesting to segregate 1 group of refiners, which treats exclusively high-grade, pure material, like Lake mineral, Arizona bars, and Montana blister copper. Works which produced 105,400,664 pounds of refined copper incurred the following total expenses:

EXPENSES IN COPPER WORKS TREATING HIGH-GRADE MATERIAL.

Wages	$326,687
Salaries	42,056
Paid to contractors	4,735
Supplies and materials	305,679
Rent, interest, etc	40,462
Total	719,619
or 0.68 cent per pound.	
Total refined copper, pounds	105,400,664

LEAD AND ZINC.

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BY CHARLES KIRCHHOFF.

Although one of the great industries, lead mining is carried on in only a few localities for the production of lead ore pure and simple. It is the usual practice to separate the product of mines into 2 groups, that in which the baser metal is associated with the precious metals, and that in which it is practically free from gold and silver. The first group includes all the mines producing lead-bearing ores in the Rocky mountains.

LEAD PRODUCT OF THE ROCKY MOUNTAIN REGION.

All the ores of this great division carry gold and silver associated with the base metal. If the principle be adopted of classifying an ore in accordance with its constituent of chief value, a few mines in the Rocky mountains might be classed as lead mines. In order to avoid the confusion, perplexity, and annoyance which would grow out of duplicate correspondence, the investigation so far as lead in the Rocky mountain region is concerned was confined to gathering data as to the lead contents of ores and their value.

Since the concentration of lead-smelting operations in certain localities and the shipment of ore for treatment from one state or territory to another, the task of tracing to its source the lead contents of ores in the Rocky mountain region has outgrown the resources of ordinary statistical research. Those familiar with the difficulties of territorially distributing the lead product of the Rocky mountain region have long since recognized that the only means of arriving at accurate results is to take a census of the mines themselves. It is to this that the present investigation has been confined, and the following summary presents the result:

SUMMARY OF LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES.

STATES AND TERRITORIES.	Tons.	Value.	STATES AND TERRITORIES.	Tons.	Value.
Total	130,903	$4,712,757.27	Montana	10,183	$456,975.40
			Nevada	1,994	72,653.64
Arizona	3,158	98,747.84	New Mexico	4,764	170,754.59
California	53	1,999.65	South Dakota	116	4,653.44
Colorado	70,788	2,101,014.31	Utah	16,675	763,329.09
Idaho	23,172	1,042,629.31			

LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES, BY COUNTIES.

ARIZONA.

COUNTIES.	Pounds.	Value.
Cochise	2,548,884	$25,223.77
Gila	370	9.97
Mohave	618,644	10,444.65
Pima	2,303,929	48,684.73
Yavapai	211,090	3,302.72
Yuma	633,257	11,082.00
Total	6,316,374	98,747.84
Equals 3,158 tons.		

CALIFORNIA.

Butte	400	8.00
Inyo	94,110	1,871.65
San Bernardino	12,000	120.00
Total	106,510	1,999.65
Equals 53 tons.		

COLORADO.

COUNTIES	Pounds.	Value.
Boulder	18,050	$190.50
Chaffee	6,614,211	57,611.40
Clear Creek	3,078,247	52,222.38
Custer	465,454	11,617.81
Dolores	338,360	6,973.00
Eagle	984,783	10,060.94
Fremont	620,800	6,208.00
Gilpin	2,026,819	35,738.28
Gunnison	934,790	17,900.33
Hinsdale	516,620	10,668.72
Lake	100,983,862	1,448,643.65
Ouray	2,666,282	39,129.88
Park	556,880	10,622.60
Pitkin	14,263,832	276,085.42
Saguache	124,774	2,545.30
San Juan	3,574,437	67,133.12
San Miguel	616,190	10,037.00
Summit	3,191,793	37,625.98
Total	141,576,184	2,101,014.31
Equals 70,788 tons.		

LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES, BY COUNTIES—Continued.

IDAHO.

COUNTIES.	Pounds.	Value.
Alturas	2,438,425	$64,438.79
Custer	1,275,193	21,215.45
Logan	5,501,370	115,040.23
Shoshone	37,128,890	841,934.84
Total	46,343,878	1,042,629.31
Equals 23,172 tons.		

MONTANA.

Beaverhead	6,906,258	169,008.45
Deerlodge	640,000	13,398.75
Fergus	39,200	793.80
Jefferson	10,161,004	247,696.65
Meagher	2,119,410	15,952.75
Missoula	500,000	10,125.00
Total	20,365,872	456,975.40
Equals 10,183 ton		

NEVADA.

Elko	60,000	980.00
Eureka	2,977,040	56,065.07
Lincoln	659,516	10,751.09
Nye	19,674	233.70
White Pine	272,415	4,623.78
Total	3,988,645	72,653.64
Equals 1,994 tons.		

NEW MEXICO.

COUNTIES.	Pounds.	Value.
Donna Ana	2,057,100	$35,916.59
Grant	3,235,310	44,623.06
Lincoln	60,000	600.00
Santa Fe	1,101,000	22,020.00
Sierra	678,853	9,536.06
Socorro	2,374,759	57,858.97
Taos	20,000	200.00
Total	9,527,022	170,754.59
Equals 4,764 tons.		

SOUTH DAKOTA.

Lawrence	232,672	4,653.44
Equals 116 tons.		

UTAH.

Beaver	8,974,084	179,293.03
Juab	260,141	4,765.38
Piute	140,375	2,885.62
Salt Lake	9,588,325	205,336.85
Summit	11,362,293	306,455.59
Tooele	2,965,171	64,442.57
Wasatch	60,000	150.00
Total	33,350,389	763,329.09
Equals 16,675 tons.		

Since, with very few exceptions, the mines producing ore carrying lead yield the precious metals in greater value, the data relating to labor, wages, and capital are comprised in the totals collected on the mining of gold and silver.

LEAD ORES OF THE MISSISSIPPI VALLEY.

While the lead-bearing ores of the Rocky mountain region are almost universally purchased by sampling works or refiners according to assay, so that their lead contents are easily reported, the product of the second group, the nonargentiferous lead mines of Kansas, Missouri, and Wisconsin, is bought without an exact determination of its lead contents. The reports of the smelters in those districts, however, indicate their grade quite clearly.

The prevalence of the leasing system placed great obstacles in the way of the work of collecting reliable statistics in Kansas, Missouri, and Wisconsin. The owners of the land lease the mining right to others for a royalty, and the lessees in many cases again sublet portions of the ground to individuals or groups of miners. In numerous instances the actual operators work only for short periods or erratically, and no records are kept of the number of employés, their outlays, or their earnings. So far as it was possible visits were made to the groups of miners, so as to arrive at some data concerning the number of persons employed, the length of time of their employment, and their earnings. Valuable data have thus been collected, notably for the Shullsburg district, in Wisconsin, where this system of collecting the statistics was most thoroughly carried out by Mr. James Freeman, of Shullsburg, involving, as it did, repeated personal interviews with the small groups of men acting in partnership. In other parts of the district, particularly at some of the isolated points, digging for zinc and lead ore is pursued in the intervals of slack work on the farms. It was not considered advisable to carry out the plan of strictly separating labor into two groups, above and below ground, because the work, even where underground mining is necessary, is not assigned strictly to different groups of men. In the smaller operations from 2 to 5 or more individuals work in partnership, sharing alike. In these cases the force has been grouped with the miners and operators. In more ambitious undertakings one or more laborers are hired by the partners at a fixed rate of wages, and have been grouped as such. The earnings of the partners have been regarded as equivalent to wages, and have been arrived at by deducting from the gross receipts for ore sold, first, the royalty paid, then the amounts expended for supplies and hauling ore, and, finally, the sums paid to hired labor. The balance has been computed as per diem wages on the basis of the reports made. In a few isolated cases the men have either lost money or have earned a very meager return for their labor. The earnings

appear to rise very rarely above the returns obtained by skilled labor. Thus the reports show that they approached $5 per day exceptionally for moderate periods of time, while they were below $1 in a surprisingly large number of instances. In the aggregate the total product of the mines thus worked by lessees, for example, in Wisconsin, is quite large, although the output of the few companies and firms regularly employing large bodies of men constitute a very heavy percentage of the total.

WISCONSIN.

As typical of the system, the following detailed tables are presented relating to Wisconsin. The mining industry in this state more closely approaches that of the primitive conditions than it does in any other part of this country. The amount of machinery employed, excepting by 1 large company, is small, and the quantity of supplies consumed is very low, even if due allowance be made for the probability that small operators did not fully report their outlays in this respect. The character of the deposits has not, apparently, lent itself readily to systematic operations on a large scale, so that the greater part of the product is the direct result of manual labor applied to small individual operations. Since they are largely surface diggings, the period of employment is short, and, considering all the circumstances, the earnings are very moderate. The individual returns indicate clearly that the element of chance enters more frequently into mining so far as the yield of lead ore is concerned. Occasionally there are large findings of this ore, which apparently contribute more frequently to exceptional earnings, although at the best they rarely exceed the rate of wages paid to skilled labor in some sections of the country. The table shows clearly that the average earnings of lessees are not much greater than those of day laborers.

In Wisconsin the number of mines producing lead ore exclusively is small, and both in tonnage and in value lead is the by-product, the main reliance being the zinc ore.

LEAD AND ZINC ORE PRODUCED IN WISCONSIN.

COUNTIES.	Total value.	Zinc ore produced. (Pounds.)	Value.	Lead ore produced. (Pounds.)	Value.
Total	$464,630.39	49,663,765	$400,567.86	3,355,159	$64,062.53
Iowa	249,864.53	33,992,803	237,462.98	811,035	12,401.55
Lafayette	180,533.68	14,264,262	152,972.88	1,457,424	27,860.80
Grant	31,172.18	1,406,700	10,132.00	966,700	21,040.18
Green	2,760.00			120,000	2,760.00

LABOR EMPLOYED IN LEAD AND ZINC MINING IN WISCONSIN.

COUNTIES.	Number of foremen.	Number of mechanics.	Number of miners or operators.	Number of laborers.	Number of boys.
Total	25	24	598	488	10
Iowa	16	5	380	224	
Lafayette	8	18	167	235	10
Grant	1	1	49	27	
Green			2	2	

EXPENSES OF LEAD AND ZINC MINING IN WISCONSIN.

COUNTIES.	Total expenses.	Total wages paid and net earnings of individual operators.	Amount paid to contractors.	Royalty paid on zinc ore.	Royalty paid on lead ore.
Total	$383,438.72	$308,566.37	$25,286.36	$43,175.73	$6,470.26
Iowa	209,908.74	166,132.52	19,788.20	22,748.55	1,239.47
Lafayette	147,654.67	120,776.61	4,623.66	19,575.59	2,678.81
Grant	23,715.31	19,302.24	754.50	851.59	2,806.98
Green	2,760.00	2,295.00	120.00		345.00

The averages of wages paid per day as given in the following and all similar tables were obtained from statements of operators, and are independent of the gross amount paid in wages:

LENGTH OF EMPLOYMENT AND EARNINGS OF LABOR IN LEAD AND ZINC MINING IN WISCONSIN.

COUNTIES.	TOTAL.		FOREMEN.		MECHANICS.		MINERS OR OPERATORS.		LABORERS.		BOYS.	
	Average daily wages.	Average days employed.	Average daily wages.	Average days employed.	Average daily wages.	Average days employed.	Average daily wages.	Average days employed.	Average daily wages.	Average days employed.	Average daily wages.	Average days employed.
Iowa	$1.99	200	$1.60	166	$2.18	185	$1.27	191	$1.30	215	.....	.....
Lafayette	2.53	262	2.18	185	1.96	286	1.45	136	1.26	246	$0.85	193
Grant	2.00	52	2.00	52	2.00	52	1.79	121	1.25	197	.....	.....
Green	.....	.....	.....	.....	.....	.....	2.57	300	1.25	300	.....	.....

SOUTHWEST MISSOURI.

The difficulty of collecting data for the lead and zinc mining industry in southwest Missouri was insuperable. The fact is that no records exist except with the larger companies, and they deal simply with product in the majority of cases. Even the statement of output was found to vary when made at various times by different officials. Those from whom the companies leased the land could furnish no information whatever as to the number of men employed, the length of their employment, or their necessary outlays and earnings. An attempt was made to reach the groups of miners acting as lessees of small tracts, but it was found that the life of many such partnerships was so short that those which had been in existence early in the census year had long dissolved, and that the majority of those reached possessed no records whatever.

The situation in the district is best characterized by the following abstract from a letter of the best-informed engineer of that section, a man of broad views and familiar with conditions in other sections of the country:

> The mining contracts which the owners of the land enter into are often erroneously spoken of as leases. There are, however, important points involved in the distinction, some landholders being careful to retain possession of the ownership of the ore and all mining rights. The landowner in many cases receives the money from the sale of all ores and pays every week to some authorized agent of the registered holders of lots, whose ores have been sold, the contract price for mining the ore and preparing it for market. That price is $25 per 1,000 pounds when pig lead is quoted at 7 cents in the Saint Louis market, and a proportionate sum as the price varies from 7 cents, and a proportionate price for inferior mineral. $2 per 1,000 pounds of lead ore are deducted and $1 per ton on zinc ore is deducted for pump rent. The price paid for zinc ore cleaned ready for market varies between 77.5 and 80 per cent of the value of the zinc contained. In the great majority of lots, which rise in number to upward of 200 for 1 company, the ore is taken out and cleaned by subcontractors. Settlements are made every week in cash, and the mining company has no means of knowing how the money which it pays out is divided. It is a question whether books are kept for a single one out of hundreds of lots which would give the figures called for in the census schedules.

These indications permit of an estimate of the total wage fund distributed.

In Missouri the product of the mines has been as follows:

PRODUCT OF LEAD AND ZINC ORES IN MISSOURI.

COUNTIES.	ZINC ORE.		LEAD ORE.	
	Pounds.	Value.	Pounds.	Value.
Total	186,262,308	$2,024,057.14	85,964,146	$1,571,161.04
Barry	360,000	2,340.00	.....	.....
Dade	306,000	1,308.00	152,000	3,240.00
Greene	1,352,430	17,139.00	660,630	9,371.50
Jasper	144,051,380	1,629,537.59	11,619,430	245,856.52
Lawrence	18,926,354	158,665.27	6,009,871	118,161.28
Madison	.....	.....	11,000,197	145,589.81
Morgan	31,000	480.00	.....	.....
Newton	16,615,144	191,487.28	339,557	7,074.00
Saint François	4,620,000	23,100.00	57,027,745	1,014,162.13
Washington	.....	.....	2,148,716	27,705.80

It will be observed that in Greene, Jasper, Lawrence, Newton, and Saint François counties the mines produce heavily both of zinc and lead ore. In the majority of instances both ores are mined from the same openings, the zinc preponderating, however, both in quantity and value. The same is true of the adjoining mining district of Cherokee county, Kansas. The smaller number of producers and the concentration of the business in the hands of larger concerns have made it possible to present more elaborate data on the industry. In the zinc ore product is included a considerable quantity of rough ore, the mining companies in some cases being unable to report the exact equivalent

in clean, merchantable ore. This accounts for the apparent excess of ore mined over the quantity used at the zinc smelters.

STATISTICS OF ZINC AND LEAD MINES IN KANSAS.

Zinc ore produced, pounds	79,150,902	
Value of zinc ore		$299,192.05
Lead ore produced, pounds	7,233,778	
Value of lead ore		108,236.42
Total value		407,428.47
Wages paid		293,197.20
Salaries		9,166.00
Contractors		700.00
Supplies and materials		53,520.02
Insurance, taxes, rent, etc		7,135.73
Total expenditures		363,718.95

MISSOURI LEAD MINES.

In order to arrive at some data which might throw light on the condition of the lead-mining industry of Missouri proper, the figures were aggregated which deal with mines in that state producing lead ore exclusively. Although there are a few diggings in the mineral belt characteristic of producing the two ores together which happened to yield only lead ore in the census year, they were omitted from the aggregate, which includes the 2 great mines of Saint François county, the Saint Joe and the Doe Run, the Mine La Motte, and the mines of Washington county. Of the 88,964,146 pounds of lead ore produced in the state of Missouri 69,532,873 pounds were from mines producing this mineral alone.

The following table shows the number of persons employed above and below ground, with the average wages per day and the average number of days worked:

STATISTICS OF MISSOURI LEAD MINES.

EMPLOYÉS.	Number employed.	Average daily wages.	Average days employed.
Total	1,118	$1.25	274
ABOVE GROUND.			
Foremen	21	2.19	332
Mechanics	106	1.63	302
Laborers	306	1.27	308
Boys	8	0.72	309
BELOW GROUND.			
Foremen	22	1.87	306
Miners	411	1.13	218
Laborers	244	1.12	305

EXPENDITURES.

Wages	$401,430.77
Paid contractors	8,525.05
Supplies, etc	244,783.84
Rent, taxes, etc	142,153.55
Total	796,893.21

It must be noted that the average wages of the miners are lowered because of the low wages paid in the Washington county mines, where $1 per day is the general rate, and as low as 70 cents per day is paid for what is not skilled miners' labor.

EASTERN AND SOUTHERN ZINC MINES.

In the east the industry differs in character from that of the west, since there is only one mining operation in Virginia in which the ores of both metals are extracted from the same deposits. The number of operators is small, and it has been deemed expedient, therefore, to place the mines in 2 natural groups, one embracing New Jersey and Pennsylvania and the other, the southern group, including Virginia and Tennessee.

STATISTICS OF EASTERN AND SOUTHERN ZINC MINES.

STOCK, CAPITAL, LABOR, ETC.	Eastern.	Southern.
Zinc ore produced, tons	63,339	12,906
Value of product	$175,052	$141,560
STOCK OF ORE:		
January 1, 1889, short tons	21,363	3,100
January 1, 1890, short tons	26,724	1,478
CAPITAL:		
Land	$612,500	$194,000
Buildings and fixtures	25,510	32,000
Tools, implements, and machinery	152,093	32,000
Cash, etc.	.....	1,000
Total	790,103	259,000
LABOR:		
Number employed above ground—		
Foremen	4	28
Mechanics	24	19
Laborers	65	586
Boys	8	45
Number employed below ground—		
Foremen	8	1
Miners	54	59
Laborers	62	2
Boys	2	1
Office force—		
Males	6	8
Total employés	233	749
Average daily wages above ground—		
Foremen	$4.02	$1.76
Mechanics	1.68	1.33
Laborers	1.15	0.99
Boys	0.59	0.50

STOCK, CAPITAL, LABOR, ETC.	Eastern.	Southern.
LABOR—continued.		
Average daily wages below ground—		
Foremen	$2.41	$3.00
Miners	1.49	1.07
Laborers	1.26	0.75
Boys	0.72	0.30
Average length of employment above ground, in days—		
Foremen	307	314
Mechanics	310	273
Laborers	302	171
Boys	312	202
Average length of employment below ground, in days—		
Foremen	310	175
Miners	279	171
Laborers	304	150
Boys	281	150
Total wages paid	$84,683	$132,949
OFFICE FORCE:		
Salaries	5,617	6,250
Supplies and materials consumed	53,039	56,595
Rent, interest, insurance, taxes, etc	37,215	6,500
Total expenditures	180,554	202,294
POWER:		
Number of steam boilers	21	5
Total horse power	1,003	130
Number of engines	12	5
Number of animals	23	101

It should be noted that one of the southern mines produced also 268 tons of lead ore, valued at $10,720. It will be observed that the working force of the eastern mines is nearly equally distributed between surface and mine labor, while practically all the work done in the southern district is in open cuts, where a large quantity of barren material must be handled.

The total product of the lead and zinc mines of the states east of the Rocky mountains has been as follows:

TOTAL PRODUCT OF THE LEAD AND ZINC MINES EAST OF THE ROCKY MOUNTAINS.

STATES.	Total value.	ZINC ORE.		LEAD ORE.	
		Short tons.	Value.	Short tons.	Value.
Total	$4,804,179.24	234,503	$3,049,799.25	50,238	$1,754,379.99
Arkansas	3,650.00	130	3,250.00	20	400.00
Illinois	4,800.00	.....	.....	173	4,800.00
Iowa	3,600.00	450	3,600.00	.....	.....
Kansas	402,428.47	39,575	299,192.05	3,617	103,236.42
Missouri	3,595,218.18	93,131	2,024,057.14	44,482	1,571,161.04
New Jersey and Pennsylvania	175,052.20	63,339	175,052.20	.....	.....
New Mexico	2,520.00	140	2,520.00	.....	.....
Southern states	152,280.00	12,906	141,560.00	268	10,720.00
Wisconsin	464,630.39	24,832	400,567.86	1,678	64,062.53

LEAD SMELTING AND REFINING.

The operations of lead smelting and refining are so inextricably mixed, and are, besides, so often conducted in connection with the parting of the precious metals, that it is quite impossible to present tables covering the operations for the whole country. Nearly all the lead refiners carry on simultaneously a certain amount of ore smelting. They can not segregate the labor and expenditures therefor from those incurred in lead desilverizing, because many intermediate products of the latter are treated together with the ore in the smelting. Others do a large amount of

refining and parting of the precious metals, in which the same obstacles are met in keeping accounts. Some couple with their lead business the refining of copper and the manufacture of bluestone. Under these circumstances it is impossible to present data sharply defining the amount of labor employed in the different branches of the industry, or to give accurate statistics concerning the wages paid and the supplies consumed for the whole country. So far as lead smelting is concerned, however, it is possible to segregate certain groups, the statistics of which are largely instructive. First among these is that comprising the works which smelt the product of the nonargentiferous ores of Kansas, Missouri, and Wisconsin. A moderate quantity of this class of ore is purchased by the lead desilverizers, who utilize it to some extent in connection with the treatment of antimonial intermediate products, with the object of obtaining antimonial lead low in silver, which accounts for the difference between the output of the mines and the quantity worked by the smelters. The following table summarizes the data relating to this group:

STATISTICS OF SMELTERS OF NONARGENTIFEROUS LEAD ORES IN ILLINOIS, KANSAS, MISSOURI, AND WISCONSIN.

Product of refined lead, short tons	29,258
Product of sublimed lead, short tons	1,250
Stock, January 1, 1889, short tons	4,058
Stock, January 1, 1890, short tons	5,367
Quantity of ore treated, short tons	49,816
Value of ore treated	$1,664,020

LABOR EMPLOYED, AVERAGE WAGES PER DAY, AND AVERAGE DAYS EMPLOYED.

EMPLOYÉS. (a)	Number employed.	Average daily wages.	Average days employed.
Total	476	$1.54	293
Foremen	21	2.31	331
Mechanics	31	1.94	273
Laborers	423	1.47	292
Boys	1	0.50	364

a Office force consists of 15 persons.

EXPENDITURES.

Total wages	$206,541
Salaries	19,680
Paid contractors	3,182
Total expenditures for supplies and materials	184,175
Rent, taxes, insurance, and all other expenditures	166,632
Total	580,210

That the ore worked is thoroughly dressed by concentration is shown by the fact that the yield averaged 61.24 per cent. Of the total, 21,456 tons is the product of 3 companies, who smelt the ores produced at their own mines. These companies paid in wages and salaries $145,540; for supplies and materials consumed, $144,983, and for rent, taxes, and miscellaneous expenditures for mine and smelting works, $165,164, the ore being valued at $1,179,769. The same concerns incurred an outlay for mine labor of $345,369, and for mine supplies of $233,341, a total direct outlay of $1,034,287. The other smelters in the group under consideration purchase their ore in the open market, quite a number of them operating only on a very small scale, the product being under 300 tons in the majority of cases.

A second group of smelters, the operations of which it is possible to segregate without risk of obscuring the results by the introduction of figures which should be assigned to allied branches of the industry, are the Colorado smelters, the aggregate embracing the reports from 9 plants, the product of base bullion being 67,867 short tons and the quantity of ore treated 602,014 short tons. This group does not include those smelters alone which did a lead-smelting business exclusively.

STATISTICS OF LEAD SMELTERS IN COLORADO.

EMPLOYÉS. (a)	Number employed.	Average daily wages.	Average days employed.
Total	1,929	$2.59	317
Foremen	47	4.17	360
Mechanics	62	3.57	345
Laborers	1,818	2.52	315
Boys	2	0.75	365

a Office force consists of 77 persons.

EXPENDITURES.

Total wages	$1,645,819.46
Salaries	206,606.81
Paid contractors	45,998.03
Value of supplies and materials consumed	1,774,340.92
Rent, taxes, and miscellaneous expenses	523,639.88
Total disbursements, exclusive of value of ore	4,196,405.10

For years a sharp competition has been waged between 2 groups of Colorado smelters, those of the Leadville and the Valley districts. The following table gives aggregates covering the operations of all the former and those of the latter which do exclusively a smelting business:

DETAILED STATISTICS OF COLORADO SMELTERS.

ITEMS.	Leadville.	Valley.
Product of base bullion, short tons	26,453	40,253
Ore treated, short tons	238,615	350,399
Total wages	$600,447	$970,373
Salaries	61,728	129,879
Paid contractors		30,998
Taxes, rent, and insurance	269,883	233,756
Supplies and materials	818,402	898,949
Total expenditures	1,750,460	2,263,955

The most striking fact illustrative of the great progress made in lead smelting is the enormous quantity of ore treated when compared with the relatively small amount of lead produced; in other words, the small quantity of the base metal in the furnace mixture. It proves what progress has been made in smelting where it is possible to add to what may be termed lead ores proper such quantities of strictly argentiferous or dry ores. The average percentage of lead in the mixtures was between 11 and 11.5. The exact amount can not be stated in the absence of any data on the silver contents of the base bullion. A decade since such results would have been unattainable without heavy losses both in the base and precious metals. The figures given illustrate to what extent smelting has become the method of treating silver ores. The cost, too, has been very considerably lowered, having apparently been in the census year $6.97 per ton of material treated, without any allowance, however, for loss of base and precious metals.

The returns from 4 Montana smelters show the product of base bullion to be 16,335 short tons, and the quantity of ore treated 71,403 short tons. The following table shows the number of employés, average wages per day, and average days employed:

STATISTICS OF MONTANA LEAD SMELTERS.

EMPLOYÉS.	Number employed.	Average daily wages.	Average days employed.
Total	457	$2.75	306
Foremen	12	5.06	327
Mechanics	22	4.90	322
Laborers	423	2.57	305

EXPENDITURES.

Total wages and salaries paid	$360,694.38
Total supplies, materials, rent, and miscellaneous expenditures	499,320.52
Total expenditures, exclusive of cost of ore	860,014.90

The contrast between the conditions under which the Montana smelters operated in 1889 and those prevailing in Colorado is well illustrated by the fact that the smelting mixture of the former yielded nearly 23 per cent of lead. The cost of treatment was apparently $12.04 per ton.

A third group of smelters in the Rocky mountains, working under conditions characteristically their own, is that of the Utah works. The returns from 3 establishments show the product of base bullion to be 12,908 short tons, and the quantity of ore treated 66,797 short tons.

The table following shows the number of employés engaged in lead smelting in Utah, average wages per day, and average number of days employed.

STATISTICS OF UTAH LEAD SMELTERS.

EMPLOYÉS. (a)	Number employed.	Average daily wages.	Average days employed.
Total	354	$2.16	327
Foremen	5	3.58	365
Mechanics	8	3.03	308
Laborers	341	2.12	327

a Office force consists of 10 persons.

EXPENDITURES.

Total wages paid	$253,805.60
Salaries	19,170.00
Paid contractors	6,532.05
Supplies and materials	362,347.14
Rent, taxes, insurance, etc	48,959.00
Total expenditures, exclusive of cost of ore	690,813.79

Special interest is attached to the operations of smelting establishments near the Mexican border in Texas and New Mexico. One of them did not begin operations until the close of the census year. The number of establishments was 3, the product of bullion was 13,733 short tons, and the quantity of ore treated was 79,168 short tons.

STATISTICS OF BORDER SMELTERS.

EMPLOYÉS. (a)	Number employed.	Average daily wages.	Average days employed.
Total	565	$2.13	319
Foremen	9	4.04	322
Mechanics	12	3.45	325
Laborers	544	2.07	319

a Office force consists of 19 persons.

EXPENDITURES.

Total wages paid	$244,674.72
Salaries	46,480.00
Paid contractors	1,350.00
Supplies and materials	479,654.48
Rent, taxes, insurance, etc	71,080.59
Total expenditures, exclusive of cost of ore	843,239.79

LEAD DESILVERIZING AND REFINING.

Practically all the lead refining and desilverizing works are also engaged in lead smelting. In some cases lead refining is a minor part of the business, while in others ore smelting plays a very subordinate part. In some instances the parting of the precious metals is the principal business, while in others the smelting and refining is an operation subsidiary to the manufacture of sheet lead, shot, and white lead. Only a few works have found it possible, therefore, to give in detail the data relating to this one particular department. An aggregate of their special reports will suffice to illustrate the conditions affecting the industry. How large the smelting operations of the works are may be understood from the fact that 4 refineries made 33,638 tons of base bullion from 108,781 tons of lead ore, and that 2 others worked 21,775 tons of ore, without, however, being able to state their lead contents. All of them lie east of the Rocky mountains. The production of refined lead amounted to 95,287 tons, and the quantity of ore smelted was 7,425 tons. The total wages paid was $373,601.98.

The following table shows the number of employés, average wages per day, and average days employed:

EMPLOYÉS.	Number employed.	Average daily wages.	Average days employed.
Total	620	$1.85	322
Foremen	15	3.48	318
Mechanics	80	2.39	352
Laborers	523	1.72	317
Boys	2	0.75	365

While it is true that 2 of the works included in the aggregate treated 7,425 tons of lead ore, it must be considered that the others which separated the two departments did not take account of the labor which would be employed in working up intermediate products in smelting them if the works did not also treat ore. Works with a product of 70,787 tons of refined lead reported that their expenditures for supplies, materials, etc., amounted to $307,784.36, while their outlays for rent, taxes, insurance, and all other expenditures amounted to $185,879.32. This does not include the salaries paid to officers, which could not well be distributed between the departments.

The following table summarizes the data for the whole lead smelting and desilverizing industry, California alone excepted. An effort has also been made to ascertain the stocks of base bullion and of refined lead in the hands of smelters and refiners in transit and in the hands of agents.

LEAD SMELTING AND REFINING WORKS.

STATES AND TERRITORIES.	PRODUCT.			STOCK.			
	Base bullion. (Short tons.)	Refined lead. (Short tons.)	Fine copper in matte. (Pounds.)	Base bullion. (Short tons.)		Refined lead. (Short tons.)	
				January 1, 1889.	January 1, 1890.	January 1, 1889.	January 1, 1890.
The United States		182,967	4,195,929	1,474	4,730	12,058	9,230
California		5,500					
Colorado	73,205	2,784	1,360,617	290	3,138	18	168
Idaho	878						
Illinois, Iowa, Kansas, Missouri, and Wisconsin (softlead)(a)		29,258				4,058	5,267
Illinois, Missouri, and Nebraska (desilverized)	33,638	114,634	2,689,229	457	852	4,739	493
Montana	19,404						
Nevada	1,328	1,104	23,218			1,280	1,402
New Jersey, Pennsylvania, and Virginia	(b)	28,507	122,865			1,963	1,883
New Mexico and Texas	13,733			116	81		
Utah	12,908	1,180		611	659		17

STATES AND TERRITORIES.	LABOR.											
	Number employed.				Average daily wages.				Average days employed.			
	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.
The United States	173	354	5,595	9	$3.98	$2.93	$2.15	$0.50	337	322	307	336
California												
Colorado	61	71	2,019	2	3.99	3.52	2.48	0.75	361	353	321	365
Idaho	4	13	21		4.50	3.50	3.00		135	135	135	
Illinois, Iowa, Kansas, Missouri, and Wisconsin (soft lead)	21	31	423	1	2.31	1.94	1.47	0.50	331	273	292	304
Illinois, Missouri, and Nebraska (desilverized)	45	151	1,333	2	4.33	2.48	1.76	0.75	360	344	289	365
Montana	14	26	493		5.05	4.72	2.63		328	322	306	
Nevada	9	9	101		4.91	4.17	3.24		177	185	125	
New Jersey, Pennsylvania, and Virginia	4	33	308	4	2.95	2.48	1.63	0.25	332	312	343	300
New Mexico and Texas	9	12	544		4.04	3.46	2.07		322	325	319	
Utah	6	8	353		3.57	3.03	2.13		365	308	321	

STATES AND TERRITORIES.	EXPENDITURES.						Office force.
	Total.	Wages.	Salaries.	Supplies and materials.	Rent, insurance, taxes, etc.	Contractors.	
The United States	$11,457,367.25	$4,228,634.15	$510,715.97	$5,154,682.04	$1,489,715.30	$73,619.79	249
California							
Colorado	4,590,932.39	1,839,360.81	243,328.01	1,898,898.75	563,346.79	45,998.03	98
Idaho	81,798.57	17,110.00	3,300.00	61,388.57			2
Illinois, Iowa, Kansas, Missouri, and Wisconsin (soft lead)	580,210.00	206,540.69	19,680.00	184,174.71	166,631.95	3,182.65	15
Illinois, Missouri, and Nebraska (desilverized)	2,787,020.77	949,787.25	99,648.00	1,278,613.11	453,497.21	5,475.20	64
Montana	1,109,236.15	433,373.58	44,920.00	555,048.09	75,894.48		16
Nevada	174,663.73	50,694.71	4,935.00	89,034.02	30,000.00		3
New Jersey, Pennsylvania, and Virginia	585,000.71	229,133.44	29,254.96	238,622.17	76,908.28	11,081.86	22
New Mexico and Texas	843,239.79	244,674.72	46,480.00	479,654.48	71,080.59	1,350.00	19
Utah	705,265.14	257,958.95	19,170.00	369,248.14	52,356.00	6,532.05	10

a Produced also 1,250 tons sublimated lead.

b Quantity of base bullion produced from 21,775 tons of ore unknown.

The production of lead in the census year compares as follows with preceding years as reported in Mineral Resources of the United States:

PRODUCTION OF LEAD IN THE UNITED STATES FROM 1825 TO 1889.

[Short tons.]

YEARS.	Total production.	Desilverized lead.	Nonargentiferous lead.	Percentage of desilverized lead.	YEARS.	Total production.	Desilverized lead.	Nonargentiferous lead.	Percentage of desilverized lead.
1825	1,500				1860	15,600			
1830	8,000				1861	14,100			
1831	7,500				1862	14,200			
1832	10,000				1863	14,800			
1833	11,000				1864	15,300			
1834	12,000				1865	14,700			
1835	13,000				1866	16,100			
1836	15,000				1867	15,200			
1837	13,500				1868	16,400			
1838	15,000				1869	17,500			
1839	17,500				1870	17,830			
1840	17,000				1871	20,000			
1841	20,500				1872	25,880			
1842	24,000				1873	42,540	20,159	22,381	47.39
1843	25,000				1874	52,080			
1844	26,000				1875	59,640	34,909	24,731	58.53
1845	30,000				1876	64,070	37,649	26,421	58.76
1846	28,000				1877	81,900	50,748	31,152	61.96
1847	28,000				1878	91,060	64,290	26,770	70.60
1848	25,000				1879	92,780	64,650	28,130	69.68
1849	23,500				1880	97,825	70,135	27,690	71.69
1850	22,000				1881	117,085	86,315	30,770	73.72
1851	18,500				1882	132,890	103,875	29,015	78.17
1852	15,700				1883	143,957	122,157	21,800	84.86
1853	16,800				1884	139,897	119,965	19,932	85.75
1854	16,500				1885	129,412	107,437	21,975	83.02
1855	15,800				1886	135,629	114,829	20,800	84.66
1856	16,000				1887	160,700	135,552	25,148	84.35
1857	15,800				1888	180,555	151,465	29,090	83.89
1858	15,300				1889	182,967	153,709	29,258	84.01
1859	16,400								

The product of the census year was 153,709 tons of desilverized lead, while the aggregate returns of the lead contents of the ores mined show 130,958 tons. The lead contents of the Mexican ore imported during 1889 were 26,570 short tons, leaving as the apparent product of the American mines 127,139 tons. The allowance for waste on the Mexican ores would moderately increase this quantity. Considering the loss in smelting and desilverizing the domestic ore, the aggregate quantity of the returns does not therefore cover the entire product, although it probably approaches it. In view of the quantities on the dumps, in stock at the smelters, and in transit, an exact balance can not be struck.

THE ZINC SMELTING AND OXIDE INDUSTRY.

The smelting of zinc or spelter and the manufacture of oxide of zinc are so closely allied in the United States that it has been found impossible to separate the data relating to them and submit a report on each. The rolling of sheet zinc is confined to 1 establishment, whose report does not admit of separate presentation. The works in New Jersey and Pennsylvania carry on the manufacture of oxide and spelter in what is practically one plant, and in some instances the spelter produced is obtained by the distillation of unmarketable color. It has therefore been deemed expedient to embrace the industries named in one report.

GEOGRAPHICAL.

The industry may be geographically grouped in 3 divisions: the western, embracing Illinois, Kansas, Missouri, and Wisconsin, the latter state making only oxide; the eastern, comprising New Jersey and Pennsylvania; and the southern, including Tennessee and Virginia.

The first group draws its supplies of ore from the southeastern Kansas, the southwestern Missouri, and the Wisconsin districts, the fuel in the majority of works being local coal. The New Jersey and Pennsylvania works obtain the greater part of their ore supply from local deposits, but occasionally draw upon distant markets. The New Jersey works make primarily oxide and relatively little spelter. The southern group, which has shown considerable development during the past few years, uses ores mined within easy access.

Nearly all the spelter produced east of the Alleghany mountains is exceptionally high in quality, some of it being exported to Europe for special purposes.

The following table embodies the data relating to the production of spelter and oxide of zinc:

PRODUCTION OF SPELTER AND OXIDE OF ZINC IN THE UNITED STATES.

[Short tons.]

STATES.	Number of establishments.	PRODUCT.		STOCK.				ORE.	
		Spelter.	Oxide of zinc.	Spelter, January 1, 1889.	Spelter, January 1, 1890.	Oxide of zinc, January 1, 1889.	Oxide of zinc, January 1, 1890.	Ore treated.	Value of ore treated.
Total	21	58,860	16,970	2,781	2,492	1,425	1,261	196,309	$4,154,403.98
Illinois and Wisconsin	3	a23,860	3,445	360	268	73	62	66,141	1,515,939.47
Kansas	6	13,658	.....	800	1,075	.....	.....	41,995	1,178,062.73
Missouri	5	11,077	351	.....	.....	100	140	20,580	727,503.33
New Jersey and Pennsylvania	4	7,075	13,174	1,041	845	1,252	1,059	53,617	590,738.45
Tennessee and Virginia	3	3,190	.....	580	304	.....	.....	13,976	141,560.00

STATES.	Total wages and salaries.	LABOR.					OFFICE FORCE.	
		Total wages. (b)	Number of employés.				Number.	Salaries.
			Foremen.	Mechanics.	Laborers.	Boys.		
Total	$1,565,260.43	$1,424,980.52	82	457	2,024	127	95	$140,279.91
Illinois and Wisconsin	575,045.48	484,190.83	25	66	800	86	54	90,854.65
Kansas	318,115.50	311,150.50	9	128	380	24	8	6,965.00
Missouri	256,612.62	237,062.62	8	210	225	2	11	19,550.00
New Jersey and Pennsylvania	299,885.39	281,475.13	16	41	438	.....	17	18,410.26
Tennessee and Virginia	115,601.44	111,101.44	24	12	181	15	5	4,500.00

STATES.	EXPENSES.			CAPITAL.				
	Expenses exclusive of wages, salaries, raw materials, and supplies.	Value of supplies and materials consumed, exclusive of ore.	Amount paid to contractors.	Total capital.	Land.	Buildings and fixtures.	Tools, implements, and machinery.	Cash.
Total	$210,913.39	$653,305.75	$15,318.84	$4,469,386.25	$613,000.00	$2,019,914.77	$975,856.50	$860,614.98
Illinois and Wisconsin	69,996.88	261,924.22	.....	1,518,920.68	139,000.00	799,000.00	357,766.13	223,154.55
Kansas	42,900.00	48,500.00	.....	538,500.00	64,000.00	281,000.00	38,500.00	155,000.00
Missouri	44,281.00	81,187.53	.....	527,321.36	40,000.00	389,914.77	60,666.00	36,740.59
New Jersey and Pennsylvania	43,885.51	210,344.00	15,318.84	1,644,644.21	350,000.00	410,000.00	449,924.37	434,719.84
Tennessee and Virginia	9,850.00	51,350.00	.....	240,000.00	20,000.00	140,000.00	69,000.00	11,000.00

STATES.	LENGTH OF EMPLOYMENT AND AVERAGE WAGES.								POWER.			
	Foremen.		Mechanics.		Laborers.		Boys.					
	Average daily wages.	Average number of days employed.	Average daily wages.	Average number of days employed.	Average daily wages.	Average number of days employed.	Average daily wages.	Average number of days employed.	Number of boilers.	Horse power of boilers.	Number of engines.	Number of animals.
Total	$2.62	331	$1.93	333	$1.48	324	$0.68	287	115	5,171	33	165
Illinois and Wisconsin	3.00	326	2.16	274	1.24	316	0.70	290	37	1,839	11	44
Kansas	2.45	356	1.93	357	1.74	336	0.75	306	13	370	6	37
Missouri	2.59	331	1.74	345	1.76	304	0.60	310	39	1,800	7	25
New Jersey and Pennsylvania	2.38	343	2.36	298	1.60	342	.....	.....	24	1,102	7	59
Tennessee and Virginia	2.46	320	2.40	294	1.35	314	0.50	240	2	60	2	.....

a Includes 9,389 tons of sheet zinc.

b Wages paid during the year.

The production of spelter in the United States has kept pace fairly well with the rapid expansion in the consumption, while, aside from the quantity used for sheet, zinc is called for by galvanizers of iron sheets and wire and by brass manufacturers. During the year 1889 the amount used for these purposes was about 50,000 short tons.

According to the reports published in Mineral Resources of the United States for years previous to 1889, the production has been as follows for a series of years:

PRODUCTION OF SPELTER IN THE UNITED STATES, BY YEARS.

	SHORT TONS.		SHORT TONS.
1873	7,343	1885	40,688
1875	15,833	1886	42,641
1880 (census year ending May 31)	23,239	1887	50,340
1882	33,765	1888	55,903
1883	36,872	1889 (census statistics)	58,860
1884	38,544		

Grouped by states, the production has been as follows for the years given:

PRODUCTION OF SPELTER, BY STATES.

[Short tons.]

STATES.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	33,765	36,872	38,544	40,688	42,641	50,340	55,903	58,860
Eastern and southern states	5,698	5,340	7,861	8,082	6,762	7,446	9,561	10,265
Illinois	18,201	16,792	17,594	19,427	21,077	22,279	22,445	23,869
Kansas	7,366	9,010	7,859	8,502	8,932	11,955	10,432	13,658
Missouri	2,500	5,730	5,230	4,677	5,870	8,660	13,465	11,077

LABOR AND WAGES.

The most striking fact in connection with the data presented on the labor engaged in the spelter and oxide of zinc industries is the full employment given to it. This is clearly shown in the table giving the length of employment. The works in the majority of cases have not reported the number of days employed with mathematical accuracy, but the schedules confirm the general result, as the question calling for a statement of the causes of idleness has almost invariably received the reply that the establishments had been busy throughout the whole year. Since in the distillation of zinc the furnaces must be operated on Sunday, the average is naturally high. None of the works reported any strikes or lockouts.

It should be noted that the reports differ in their classification of labor. Some of the managers have included under "Mechanics" all the skilled labor in their establishments, while others have reported only carpenters, masons, blacksmiths, etc., as belonging under that head, placing the furnace men, etc., under the head of "Laborers". In the latter case the figures reported show that the special class of labor, in the particular instances in which this system was followed, received wages only slightly higher than those of common labor and as low as those paid in other sections for the latter. This explains the apparent anomaly in the case of Missouri, where the average daily wages of mechanics was only $1.74, while that of common laborers was $1.76.

QUICKSILVER.

QUICKSILVER.

BY JAMES BUTTERWORTH RANDOL.

PRESENT STATE OF THE INDUSTRY.

The quicksilver industry during the last decade has remained in the same depressed condition. No new discoveries have been made, and the old mines are becoming exhausted to such a degree as to indicate a rather doubtful future notwithstanding the somewhat improved prices, which should tend to a new stimulus in prospecting as well as in producing.

The New Almaden mine, once the proud rival of the Almaden mine in Spain, has given up its second place to the Idria mine in Austria, and the prospects for regaining its lost rank are not very encouraging. The same may be said of the other California mines. All have had similar experience, as shown by the table below. The New Almaden, with a production of 23,465 flasks in 1880, produced in 1889 only 13,100 flasks. The Sulphur Bank, with 10,706 flasks in 1880, produced only 2,283 in 1889; the Great Western produced 6,442 flasks in 1880 against 556 in 1889, while the Guadalupe, a mine in 1880 producing 6,670 flasks, has produced nothing since 1885.

COMPARATIVE TABLE OF QUICKSILVER PRODUCTION IN 1889 AND 1880.

[Flasks.]

COMPANIES.	1889.	1880.	Increase.	Decrease.
Total	*a*26,484	59,926	2,114	35,556
New Almaden	13,100	23,465	.....	10,365
Ætna / Napa Consolidated	4,590	4,416	174	.....
Great Western	556	6,442	.....	5,886
Sulphur Bank	2,283	10,706	.....	8,423
New Idria	980	3,209	.....	2,229
Great Eastern	1,345	1,279	66	.....
Redington	812	2,139	.....	1,327
Guadalupe	.....	6,670	.....	6,670
Bradford	1,874	.....	1,874	.....
Various companies	*a*944	1,600	.....	656

a Includes 20 flasks from Oregon.

This table shows improvement only in 3 cases, while in all the others a very serious decrease has taken place, the aggregate of production having decreased 55.84 per cent.

The prices for quicksilver, on the contrary, have shown an improvement, the highest and lowest quotations per flask in 1880 being $34.45 and $27.55, against $50 and $40, respectively, in 1889, a total improvement of 45.16 per cent. This improvement in prices has given some encouragement to prospectors, but with no satisfactory results. The total approximate valuation during the decade from 1870 to 1879, inclusive, was $24,322,500, against $13,480,500 in the last decade—a serious loss, with impoverished mining properties.

The world's production in 1880 was 122,536 flasks, of which the California mines produced nearly one-half, while with a total production of 113,842 flasks in 1889 California only claims 23.25 per cent.

New utilizations for the metal have not been discovered, and the general depression in the Comstock mines has had a very depressing effect on the quicksilver market. The shipments to China and South America ceased altogether in 1889, and shipments to other countries have largely decreased. The total foreign shipments from San Francisco in 1880 were 34,648 flasks, against 5,189 flasks in 1889.

CENSUS STATISTICS.

During the calendar year 1889 there were 26,464 flasks, or 2,024,496 pounds, or 1,012 short tons of quicksilver produced in California. About 20 flasks, less than $1,000 in value, were produced in Oregon. The product is notably less than the usual yield. In 1888, 33,250 flasks were produced.

ESTABLISHMENTS.

In the following table, under the heading of "Productive mines and furnaces", is included every establishment in the United States where cinnabar ore is known to have been mined and quicksilver produced therefrom to the amount of $1,000 or more during the period under review. The nonproductive mines and furnaces include establishments the stoppage of which was caused, among other reasons, by litigation, by low prices for quicksilver and the consequent unprofitable results for the time being, or by lack of sufficient capital and experience to pursue a hazardous industry. It is considered probable that all of those establishments now closed and unproductive will resume work when higher and more remunerative prices for quicksilver can be obtained.

The productive mines and furnaces, with few exceptions, were operated continuously throughout the year, omitting holidays and Sundays.

LOCATION AND NUMBER OF ALL THE QUICKSILVER ESTABLISHMENTS, BY STATES AND COUNTIES.

STATES.	Counties.	PRODUCTIVE.		NONPRODUCTIVE.	
		Mines.	Furnaces.	Mines.	Furnaces.
Total		11	36	6	7
California	Lake	3	12	.....	.....
Do	Merced	1	(a)	.....	.....
Do	Napa	4	12	.....	.....
Do	San Benito	1	3	.....	.....
Do	Santa Clara	1	7	1	4
Do	Sonoma	1	2	.....	.....
Do	Siskiyou	.....	.....	1	(a)
Do	Trinity	.....	.....	1	.....
Oregon	Douglas	.....	.....	3	3

a One retort.

The productive mines and active furnaces employed 937 operatives, of whom 416 were engaged on surface work and 521 were employed underground. The other mines and furnaces employed 24 men, making a total of 961 employés, as shown in the following table:

NUMBER OF EMPLOYÉS.

EMPLOYÉS.	Total.	Productive mines and furnaces.	Nonproductive mines and furnaces.
Total	961	937	24
Men	956	932	24
Women	1	1	.....
Boys	4	4	.....
Total on surface	434	416	18
Total underground	527	521	6

PRODUCTION STATISTICS.

Of 95,714 tons (2,000 pounds each) of cinnabar ore mined, 92,964 tons were roasted, producing 26,464 flasks of quicksilver, each containing a standard quantity of 76.5 pounds avoirdupois. Of the 11 establishments working ore, 1 reported only 200 tons produced and worked in retorts, with an average yield of 2.295 per cent, the highest percentage returned. The lowest average yield was 0.286 per cent, and the average percentage yield in quicksilver for all the ore roasted was 1.089. The largest quantities of ore produced and roasted by a single establishment were, respectively, 28,007 and 28,887 tons, and the quantity of quicksilver produced at the several works ranged from 120 to 13,100 flasks.

The following table exhibits the quantity of ore produced and roasted in 1889, the number of flasks of quicksilver produced, and the percentage of yield:

YIELD OF QUICKSILVER FROM ORES ROASTED IN 1889.

NUMBER OF ESTABLISHMENTS.	Ore produced. (Short tons.)	Ore roasted. (Short tons.)	Quicksilver produced. (Flasks.)	Yield. (Per cent.)
1	7,168	7,168	1,874	1.000
1	9,880	9,880	2,283	0.884
1	7,440	7,440	556	0.286
1	260	260	120	2.295
1	4,742	3,992	812	0.778
1	23,500	23,500	4,590	0.747
1	3,400	3,400	804	0.905
1	3,377	3,377	980	1.110
1	28,007	28,887	13,100	1.735
1	7,000	5,120	1,345	1.005
1	1,000	.....	.....	.....
11	95,774	92,904	*a*26,464	1.089

a One mine in Oregon produced 20 flasks, the total product in that state; they are not included, being less than $1,000 in value.

EXPENDITURES.

The following table shows the value of supplies of all kinds consumed during the year 1889, the aggregate of all wages paid, total of all other expenditures for mines and works, including rent, taxes, etc., number of flasks of quicksilver produced, and average cost per flask:

EXPENDITURES IN THE PRODUCTION OF QUICKSILVER IN 1889, NUMBER OF FLASKS PRODUCED, ETC.

NUMBER OF ESTABLISHMENTS.	Value of all supplies.	Aggregate of all wages.	Total of all other expenditures.	Number of flasks of quicksilver produced.	Average cost per flask.
1	$53,567	$104,608	$760	4,590	$34.63
1	5,975	8,060	.....	.....	(*a*)
1	*b*4,000	20,936	750	804	31.95
1	4,000	12,591	1,000	812	21.66
1	9,564	43,241	1,042	1,874	28.73
1	21,973	47,208	2,507	2,283	31.40
1	9,034	25,352	2,167	556	65.74
1	1,500	2,250	.....	120	31.25
1	3,114	27,546	79	980	31.37
1	56,428	204,341	26,826	15,100	31.88
1	20,467	30,156	359	1,345	37.90
11	219,622	626,289	35,490	26,464	33.31

a Ore mined, but none roasted, and therefore omitted in average cost per flask.
b Estimated; correct amount unobtainable.

From the above table it will be seen that at 11 active establishments there were expended $219,622 for supplies, $626,289 for wages, and $35,490 for other expenses, embracing taxes, rent, interest, etc., making a total of $881,401, showing that 71.05 per cent was paid for wages, 24.92 per cent for supplies, and 4.03 per cent for all other expenses. Of the amount paid for wages the office force absorbed $34,966, and there were paid to foremen, mechanics, miners, furnace hands, and laborers $591,323.

PRICES.

The cost per flask of quicksilver produced ranged from $65.74 to $21.66, the average cost for all being $33.31. The following table gives the highest and lowest price monthly for quicksilver:

PRICE OF QUICKSILVER IN SAN FRANCISCO DURING 1889.

MONTHS.	Highest.	Lowest.	MONTHS.	Highest.	Lowest.	MONTHS.	Highest.	Lowest.
January	$43.00	$41.50	May	$45.00	$41.00	September	$47.50	$47.00
February	42.00	41.50	June	50.00	46.50	October	47.00	46.50
March	41.00	40.00	July	47.50	46.50	November	48.00	46.00
April	41.00	40.00	August	47.50	46.00	December	47.50	47.00

For the year the highest price per flask for quicksilver was $50 and the lowest $40. The total valuation of the year's production was $1,190,500. The difference between the cost, $881,401, and value, $1,190,500, is $309,099, which may be regarded as the profit on the year's work, based on the returns collected. The difference between average cost and average sale price was $11.69 per flask.

The establishment producing quicksilver at a cost of $65.74 per flask met with a serious loss on its output, and no establishment made a profit commensurate with the risks attending the mining of cinnabar, its manufacture into quicksilver, and finding for it a market in competition with rich and important establishments carried on by foreign governments.

WAGES.

The wages in the table appended show considerable variations, depending largely upon the locality of the work, its importance, and the degree of skill required for its performance. On work at surface foremen were reported to earn daily wages ranging from $10.33 to $2.66; mechanics, $3.60 to $2.05; laborers, $2 to $1.18, the last-named rate being for Chinamen. Boys under 16 years of age, of whom only 4 were employed, none underground, earned from $1 to 75 cents.

The following table gives the number and classification of employés on surface (excepting the office force), daily wages, and number of days worked during the year:

NUMBER OF EMPLOYÉS ABOVE GROUND, WAGES, ETC., IN QUICKSILVER MINING.

NUMBER OF ESTABLISHMENTS.	FOREMEN.			MECHANICS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	1	$2.90	365	*a* 5	$2.80	301
1	2	10.33	360	5	2.50	360
1	1	2.81	157	3	3.20	90
1	.....	.....	.....	1	3.60	300
1	4	2.86	349	*b* 42	2.38	306
1	1	2.75	340	5	3.00	340
1	.....	.....	.....	2	2.05	329
1	2	2.66	365	.....	.....	.....
8	11	*c* 10.33	*c* 365	63	*c* 3.60	*c* 360
		d 2.66	*d* 157		*d* 2.05	*d* 90

NUMBER OF ESTABLISHMENTS.	LABORERS.			BOYS UNDER 16 YEARS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	*e* 11	$1.38	300	.....	.....	.....
1	15	1.75	360	.....	.....	.....
1	6	2.00	300	.....	.....	.....
1	17	1.73	265	.....	.....	.....
1	*f* 87	1.18	284	.....	.....	.....
1	*g* 98	1.94	281	3	$0.75	187
1	38	2.00	340	1	1.00	310
1	*f* 12	1.30	300	.....	.....	.....
1	*f* 2	1.37	303	.....	.....	.....
9	286	*c* 2.00	*c* 360	4	*c* 1.00	*c* 310
		d 1.18	*d* 265		*d* 0.75	*d* 187

a Mechanics comprise engineers, $2.90; blacksmiths, $2.90; and furnace men, $2.65 per day.

b Mechanics comprise carpenters, $3; masons, $5; blacksmiths, $2.10; helpers, $1.93; engine drivers, $2.30; machinists and helpers, $3.67 as their average earnings per day.

c Highest.

d Lowest.

e Laborers embrace men sorting ore, $1.25; teamsters, $1.65 per day.

f Chinese.

g Laborers comprise furnace hands, $2 to $2.25; ordinary laborers, $2; ore cleaners, $1.75 per day.

One establishment reported 42 men employed on surface and underground work without classification or number of days employed, miners at $2.10 and laborers at $1.75 per day. Another establishment reported 11 white men on surface without classification, at $2.80 per day for 352 days. These establishments were not included in the tables.

The tables on the following page exhibit the number and classification of workers underground, their daily wages, and the number of days worked during the year. For foremen at underground work the average wages ranged from $4.68 to $2.75 per day. Miners earned an average of $2.67 to $1.22, the lowest rate being for Chinamen, of whom a few were employed at small establishments.

TOTAL NUMBER OF EMPLOYÉS UNDERGROUND.

Foremen	9
Miners	378
Laborers	*a*134

a 53 unclassified, of which 32 were reported as Chinese, without classification, 362 days, at $1.17 per day.

WAGES OF FOREMEN AND MINERS UNDERGROUND.

NUMBER OF ESTABLISHMENTS.	FOREMEN.			MINERS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	1	$2.90	340	*a*6	$2.40	300
1	1	4.00	360	20	2.67	330
1	.....	.....	.....	22	2.45	263
1	1	2.75	110	*b*5	1.22	40
1	2	4.68	306	*c*233	2.66	279
1	3	3.06	340	*b*89	1.25	341
1	1	4.50	316	6	2.05	284
1	.....	.....	.....	6	1.50	236
8	9	*d*4.68	*d*360	378	*d*2.67	*d*360
		*e*2.75	*e*110		*e*1.22	*e*40

a Miners embrace timbermen and machine drill men.
b Chinese.
c Miners comprise tributers, $2.41; drillers per foot on contract, $2.33; drifting on contract, $2.80; timbermen, $3; blasters, $2.75 per day.
d Highest.
e Lowest.

WAGES OF LABORERS UNDERGROUND.

NUMBER OF ESTABLISHMENTS.	LABORERS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.
1	*a*24	$1.90	290
1	5	2.17	360
1	1	2.00	300
1	19	2.09	267
1	*a*25	1.50	340
1	3	1.65	315
1	4	1.35	326
7	81	*b*2.17	*b*360
		*c*1.35	*c*267

a Laborers embrace helpers and hand drillers at $1.90 per day.
b Highest.
c Lowest.

The following table gives the number of office force, total pay of same, total wages of all other employés, and the aggregate wages paid to all employés:

NUMBER OF OFFICE FORCE, TOTAL WAGES, ETC.

NUMBER OF ESTABLISHMENTS.	Number of office force employed.	Total wages paid to all employés.	Total pay of office force.	All other wages.
1	.....	$25,352	.....	$25,352
1	.....	2,250	.....	2,250
1	.....	20,936	.....	20,936
1	1	30,156	$800	29,356
1	3	43,241	2,520	*a*40,721
1	2	27,546	3,900	23,646
1	2	47,208	3,366	43,842
1	7	304,341	17,560	*b*286,781
1	3	104,608	5,200	99,408
1	1	12,591	1,200	*d*11,391
1	1	8,069	420	7,649
11	*c*20	626,289	34,966	591,323

a $300 paid to contractors included.
b $10,606 paid to contractors included.
c Includes 1 female, the only one employed.
d $375 paid to contractors included.

During the census decade, 1880–1889, inclusive, there were no strikes or labor troubles of any kind in any of the mines and works, and fair wages for good work was the rule for employers and employés.

POWER.

The active establishments employed 62 steam motors with a capacity of 2,190 horse power, 1 electric dynamo and motor of 4 horse power, and 1 water wheel of 3 horse power, a total of 2,197 horse power in motors. 54 boilers were employed, with a capacity of 2,438 horse power. 247 animals were also reported as employed, but it is probable a greater number were in use. The details for the respective establishments are shown in the following table:

POWER USED IN QUICKSILVER MINING AND REDUCTION.

NUMBER OF ESTABLISHMENTS.	STEAM MOTORS.		OTHER MOTORS.		BOILERS.		Number of animals.
	Number.	Horse power.	Number.	Horse power.	Number.	Horse power.	
1	2	50	.....	.....	2	30	4
1	5	230	.....	.....	5	140	4
1	3	90	.....	.....	2	125	4
1	2	150	.....	.....	5	155	12
1	2	50	.....	.....	4	100	12
1	7	185	.....	.....	5	400	15
1	29	1,000	2	*a*7	23	1,088	114
1	5	170	.....	.....	3	200	52
1	7	265	.....	.....	5	200	20
1	.....	.....	.....	.....	.....	.....	10
10	62	2,190	2	7	54	2,438	247

a One water wheel of 3 horse power, and 1 dynamo and motor of 4 horse power.

The following statement gives an estimated valuation of the active mines and works as nearly as the same could be ascertained:

VALUE OF QUICKSILVER ESTABLISHMENTS.

NUMBER OF ESTABLISHMENTS.	Total capital. (*a*)	Mines and real estate.	Furnaces, houses, and other surface improvements.	Machinery, supplies, tools, and live stock.	Quicksilver unsold.	Bills and accounts receivable.	Other assets.
1	$590,553	$276,530	$50,000	$58,850	$96,660	.....	$108,513
1	50,000	30,000	13,300	2,000	4,700	.....	.....
1	108,460	65,000	25,000	10,000	6,460	.....	2,000
1	24,335	6,940	14,000	3,300	95	.....	.....
1	32,500	20,000	5,000	5,000	2,500	.....	.....
1	155,000	100,000	25,000	30,000	.....	.....	.....
1	27,000	12,000	5,000	10,000	.....	.....	.....
1	50,466	20,000	10,000	5,000	859	$9,664	4,943
1	122,900	50,000	25,000	10,000	2,900	25,000	10,000
1	59,900	25,000	15,000	10,000	9,900	.....	.....
b 6	112,000	75,000	35,000	2,000	.....	.....	.....
16	1,333,114	680,470	222,300	146,150	124,074	34,664	125,456

a Estimated. *b* Nonproductive.

Some mine owners placed a higher valuation on their mines and improvements than is given in the foregoing statement, but it is preferred to take what may be considered a conservative opinion of the values as of December 31, 1889. Undoubtedly the original investments in the properties were many times the amounts of present estimates, but it must be remembered that mines are generally decreased in value by the extraction of ore for a long period of continuous work, which has been the case with the quicksilver establishments of the United States.

STATISTICS FOR EARLIER PERIODS.

The earliest records relating to the production of quicksilver in California are for 1850, cinnabar having been first discovered there in 1845. But very little quicksilver was produced prior to 1850, when active work was commenced at New Almaden. Outside of California quicksilver has been produced in 2 localities in the United States: in Oregon, to the extent of 2,000 flasks, and in Utah, where about 200 flasks were reported.

EARLIER CENSUS INFORMATION.

Examination of the United States census reports from 1790 to 1880 in relation to the quicksilver industry shows that no account had been taken of the industry prior to 1860. At that date and in the subsequent reports for 1870 and 1880 the information is quite limited. The following is a summary of the information relating to cinnabar and quicksilver in the census reports prior to 1890, all for the state of California, except the instances noted for 1880:

QUICKSILVER STATISTICS OF THE CENSUS OF 1860. (*a*)

COUNTIES.	Number of establishments.	Capital invested.	Cost of raw material.	Number of hands employed.	Cost of labor.	Value of product.
Total	3	$3,112,000	$166,100	335	$159,000	$382,000
Fresno (*b*)	1	100,000	15,400	110	87,000	152,000
Santa Clara	2	3,012,000	150,700	225	72,000	230,000

a Census report for 1860, "Manufactures of the United States", pages 24, 28, 36, 722. *b* Should be Monterey county.

The census of 1870, in the volume of industry and wealth, contains 3 tabular statements relating to quicksilver and cinnabar, the latter being the ore from which quicksilver is extracted by roasting, and not by smelting, as the table indicates. It will be noted that of the 3 tables the last gives figures largely different from the first 2, although apparently embracing the same subject, and it would appear that all are without real value for want of accuracy.

QUICKSILVER STATISTICS OF THE CENSUS OF 1870. (*a*)

Establishments	4
Steam engines:	
Number	1
Horse power	64
Water wheels:	
Number	1
Horse power	12
Employés	256
Males	248
Youth	8
Capital	$3,500,000
Wages	$181,000
Materials	$837,800
Products	$1,027,680

a Mechanical and manufacturing industries, quicksilver smelted.

SMELTING INDUSTRIES, BY COUNTIES.

COUNTIES.	Establishments.	Employés.	Capital.	Wages.	Materials.	Products.
Total	4	256	$3,500,000	$181,000	$837,800	$1,027,680
Fresno (*a*)	1	87	250,000	70,000	238,600	420,000
Lake	1	75	250,000	50,000	100,500	166,230
Santa Clara	2	94	3,000,000	61,000	398,700	441,450

a Should be Monterey county.

CINNABAR INDUSTRIES.

COUNTIES.	Establishments.	STEAM ENGINES.		EMPLOYÉS.				Capital.	Wages.	Materials.	Products.
		Number.	Horse power.	Total.	Men above ground.	Men below ground.	Boys above ground.				
Total	4	3	71	811	410	382	19	$11,960,000	$599,000	$30,700	$817,700
Fresno (*a*)	1	.....	.....	263	263	.....	.....	150,000	215,000	2,000	330,000
Lake	1	.....	.....	75	75	.....	.....	250,000	50,000	6,500	100,000
Santa Clara	2	3	71	473	72	382	19	11,500,000	334,000	22,200	387,700

a Should be Monterey county.

On page 767 of volume III, Ninth Census reports, the total of the above figures is given as the amount of cinnabar produced in the United States.

In the Tenth Census reports of 1880 all that relates to quicksilver and cinnabar is to be found in volume XIII, "Precious metals". No statements of production, employés, cost, etc., are given, but the localities of important deposits are mentioned, and will be referred to for comparison:

Cinnabar is the only quicksilver ore of commercial importance, and it is found in numerous localities in California, in the coast range of mountains for 100 or 150 miles north and south of San Francisco, not in well-defined veins, but commonly in irregular bodies distributed through metamorphic rocks of cretaceous age. The usual gangue minerals are quartz, calcite, and magnesite.

In the New Almaden mine, which has been much more extensively worked than any other in the state, these bodies appear, from a model constructed by the owners, to lie on a curved surface, indicating a geometrical relation between the positions of the several ore bodies, though an obscure one. At this mine the masses of ore are usually connected by tiny seams of the same material. There is a strong similarity between this mode of occurrence and that of many lead-ore deposits on the limestone, and it may be that the problem of their true character is the same.

The quicksilver country north of San Francisco is a volcanic region, while to the south volcanic rocks are subordinate in some localities and wanting in others. No general inference as to the genesis or age of the deposits can be drawn without further investigation, while the great similarity in the association of minerals suggests similar origin for most of them. (*a*)

As in the census reports of 1860 and 1870, in 1880 Fresno county is credited with the possession of the New Idria mine, which at the last date properly belongs to and is included in the boundaries of the adjoining county of San Benito. This mine is yet in operation, though no longer of importance. (*b*) The ore is distributed in metamorphic sandstone and shale (*c*). The mines mentioned as in Lake county, the Great Western and Sulphur Bank, are still operated with diminished results (*b*), and in Napa county (*d*) the Redington mine is no longer "one of the most important quicksilver producers in the state"; while the Napa Consolidated mine, also mentioned, is now included with the largest producers (*b*). The occurrence of cinnabar is noted in San Luis Obispo county (*e*), but the mines named, the Oceanic and Polar Star, have ceased to be producers, and no others have replaced them.

The chief mineral resources of Santa Clara county (*f*) are stated to be the cinnabar deposits of New Almaden and Guadalupe, and this still continues to be the case, although the last named has not been an active establishment since 1885. The New Almaden mine is still the largest quicksilver producer in the United States, but its yearly yield is much less than formerly. (*b*)

Santa Barbara county (*g*) is the most southern point where the occurrence of cinnabar is noted, and its single mine, Las Prietas, has long ceased to be active. The Great Eastern is named as the chief mine in Sonoma county (*g*), and it is now the only one in operation there. Reference is made to the Altoona mine, in Trinity county (*g*), now classed with the inactive mines, and that closes the list for California in the Tenth Census.

Douglas county, Oregon (*g*), is credited with the New Idrian mine, which still exists under another name, but was not a producer at the Eleventh Census. In the tables of the present report for the Eleventh Census 2 other mines in the same county are included under the head of "Unproductive mines", but they show fair promise for future production. The occurrence of ore seems to be similar to that of California mines, and it represents the northern end of the series of deposits, the southern extremity of which is in Santa Barbara county, California. "It would be incorrect, however, to characterize the entire series as a 'belt', for toward the north the known occurrences are at long intervals." (*g*) The considerable quantities of float cinnabar mentioned as having been found in Idaho (*h*) are not known to have added to the quicksilver supply, and if there are any quicksilver mines in that state they have not been reported.

Utah is the last on the list, "with several quicksilver claims, the most important of which are the Geyser and Jenny Lind". In 1880 the developments were "very limited, no attempts having been made to reduce the ore" (*i*), and since that date they have made no sign. Mention is also made of cinnabar in Piute county. After the Tenth Census year this claim was worked as the Lucky Boy mine. It is situated about 6 miles south of Marysville, and was idle in 1889. Previously it had produced about 200 flasks of quicksilver. The ore is a selenide of mercury.

In 1889 Colorado and Arizona made claims to recognition as having cinnabar deposits. No quicksilver has been produced within their borders, but specimens of low-grade ores are reported.

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a Compare Tenth Census, volume XIII; United States geological survey, volume XIII, and Professor S. B. Christy, American Journal of Science and Arts, volume XVII, June, 1879.

b See tables of yearly production, page 188.

c Tenth Census report, volume XIII, page 18.

d Tenth Census report, volume XIII, pages 19 and 20.

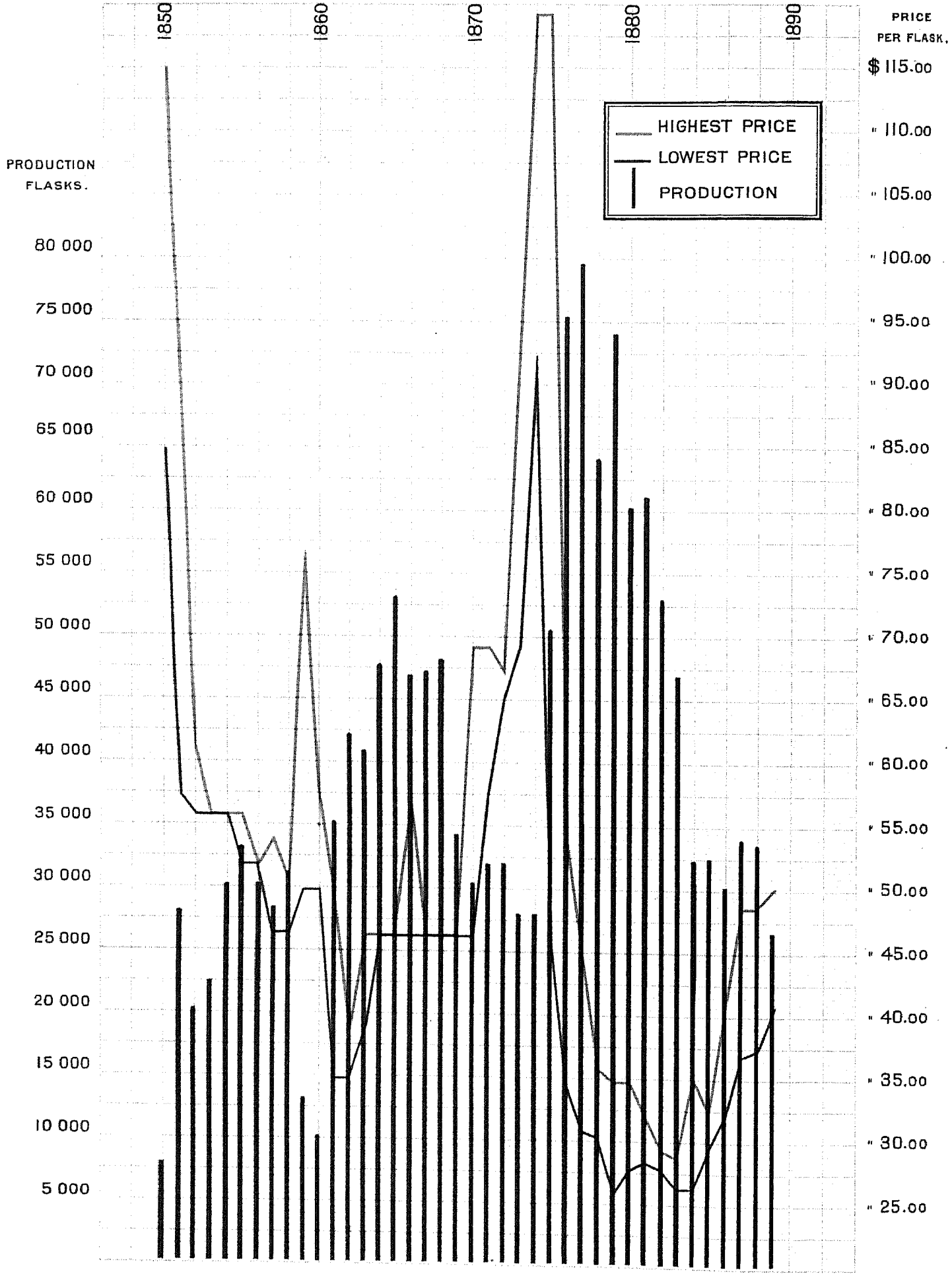
e Tenth Census report, volume XIII, page 23.

f Tenth Census report, volume XIII, page 24.

g Tenth Census report, volume XIII, pages 24, 25, 26, and 27.

h Tenth Census report, volume XIII, page 55.

i Tenth Census report, volume XIII, pages 455 and 462.



PRODUCT AND PRICE OF QUICKSILVER FROM 1850 TO 1890 BY J.B.RANDOL.

PRODUCTION OF QUICKSILVER IN THE UNITED STATES, BY DECADES.

In the following table is presented the production of quicksilver in California, which includes the whole production of the United States for the census year 1850 to the calendar year 1890, both inclusive. It is given, in addition to the detailed tables which follow, for the purpose of showing at a glance the rise and decline of the industry.

QUICKSILVER PRODUCTION IN CALIFORNIA AT PERIODS OF 10 YEARS FROM 1850 TO 1890.

[Flasks.]

YEARS.	Total.	New Almaden.	New Idria.	Guadalupe.	Redington.	Pope Valley.	Sulphur Bank.	Great Western.	Napa Consolidated.	Great Eastern.	Altoona.	Oakland.	California.	Bradford.	Ætna.	Various mines.
1850	7,723	7,723	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1860	10,000	7,061	1,469	1,470	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1870	30,077	14,423	9,888	.....	4,546	1,220	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1880	59,926	23,465	3,209	6,670	2,139	275	10,706	6,442	a4,416	1,279	245	166	422	.....	.....	b492
1890	22,926	12,000	977	.....	595	.....	1,608	1,334	2,498	1,046	.....	.....	.....	1,290	931	c737

a Including Ætna. b From the Saint John mine. c Principally from the Manhattan mine.

In the following table the total product of quicksilver for the United States in each year of the industry is associated with its approximate value:

ANNUAL QUICKSILVER PRODUCT IN THE UNITED STATES, WITH ITS VALUE.

YEARS.	Yield in California. (Flasks.)	Approximate valuation.	YEARS.	Yield in California. (Flasks.)	Approximate valuation.
Total 1850-1859 ..	242,994	$13,717,000	Total 1870-1879 ..	491,066	$24,322,500
1850	7,723	768,000	1870	30,077	1,725,500
1851	27,779	1,859,000	1871	31,686	1,999,500
1852	20,000	1,166,500	1872	31,621	2,086,000
1853	22,284	1,235,500	1873	27,642	2,226,500
1854	30,004	1,665,500	1874	27,756	2,919,000
1855	33,000	1,768,000	1875	50,250	2,721,000
1856	30,000	1,549,500	1876	75,074	3,303,000
1857	28,204	1,402,000	1877	79,396	3,041,000
1858	31,000	1,482,500	1878	63,889	2,101,500
1859	13,000	820,500	1879	73,634	2,199,500
Total 1860-1869 ..	403,109	17,738,000	Total 1880-1889 ..	a407,675	13,480,500
1860	10,000	535,500	1880	59,926	1,860,000
1861	35,000	1,473,500	1881	69,851	1,810,000
1862	42,000	1,526,500	1882	52,732	1,500,000
1863	40,531	1,705,000	1883	46,725	1,275,000
1864	47,489	1,761,500	1884	31,913	975,000
1865	53,000	2,433,000	1885	32,073	970,000
1866	46,550	2,403,000	1886	29,981	1,060,000
1867	47,000	2,157,000	1887	a33,760	1,425,000
1868	47,728	2,191,000	1888	33,250	1,415,000
1869	33,811	1,552,000	1889	a26,464	1,190,500

a 65 flasks in 1887 and 20 flasks in 1889 from Oregon not included.

RECAPITULATION.

DECADES.	Flasks.	Value.
Total	a1,544,844	$69,258,000
1850-1859	242,994	13,717,000
1860-1869	403,109	17,738,000
1870-1879	491,066	24,322,500
1880-1889	a407,675	13,480,500

a 85 flasks from Oregon not included.

The annual contribution which each mine has made to the total product is given below:

TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES.

[Flasks.]

YEARS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa Consolidated.	Great Eastern.	Bradford.
Total	1,544,929	904,359	132,214	99,264	83,475	55,910	57,063	11,557	48,847	14,944	7,093
1850	7,723	7,723	.....	.....	.....	.....	.....	.....	.....	.....	.....
1851	27,779	27,779	.....	.....	.....	.....	.....	.....	.....	.....	.....
1852	20,000	15,901	.....	.....	.....	.....	.....	.....	.....	.....	.....
1853	22,284	22,284	.....	.....	.....	.....	.....	.....	.....	.....	.....
1854	30,004	30,004	.....	.....	.....	.....	.....	.....	.....	.....	.....
1855	33,000	29,142	.....	.....	.....	.....	.....	.....	.....	.....	.....
1856	30,000	27,138	.....	.....	.....	.....	.....	.....	.....	.....	.....
1857	28,204	28,204	.....	.....	.....	.....	.....	.....	.....	.....	.....
1858	31,000	25,761	.....	.....	.....	.....	.....	.....	.....	.....	.....
1859	13,000	1,294	.....	.....	.....	.....	.....	.....	.....	.....	.....
1860	10,000	7,061	.....	.....	.....	.....	.....	.....	.....	.....	.....
1861	35,000	34,429	.....	.....	.....	.....	.....	.....	.....	.....	.....
1862	42,000	39,671	.....	444	.....	.....	.....	.....	.....	.....	.....
1863	40,531	32,803	.....	852	.....	.....	.....	.....	.....	.....	.....
1864	47,489	42,489	.....	1,914	.....	.....	.....	.....	.....	.....	.....
1865	53,000	47,194	.....	3,545	.....	.....	.....	.....	.....	.....	.....
1866	46,550	35,150	6,525	2,254	.....	.....	.....	.....	.....	.....	.....
1867	47,000	24,461	11,493	7,862	.....	.....	.....	.....	.....	.....	.....
1868	47,728	25,628	12,180	8,686	.....	.....	.....	.....	.....	.....	.....
1869	33,811	16,898	10,315	5,018	.....	.....	.....	.....	.....	.....	.....
1870	30,077	14,423	9,888	4,546	.....	.....	.....	.....	.....	.....	.....
1871	31,686	18,568	8,180	2,128	.....	.....	.....	.....	.....	.....	.....
1872	31,621	18,574	8,171	3,046	.....	.....	.....	.....	.....	.....	.....
1873	27,642	11,042	7,735	3,294	.....	.....	340	.....	.....	.....	.....
1874	27,756	9,084	6,911	6,678	573	.....	1,122	.....	.....	.....	.....
1875	50,250	13,648	8,432	7,513	5,372	3,342	3,384	.....	.....	412	.....
1876	75,074	20,549	7,272	9,183	8,367	7,381	4,322	.....	573	387	.....
1877	79,396	23,996	6,316	9,399	10,993	6,241	5,856	.....	2,229	595	.....
1878	63,880	15,852	5,138	6,686	9,465	9,072	4,963	.....	3,049	1,366	.....
1879	73,684	20,514	4,425	4,516	9,249	15,540	6,333	.....	3,605	1,455	.....
1880	59,926	23,465	3,209	2,139	10,706	6,670	6,442	.....	a4,416	1,279	.....
1881	60,851	26,060	2,775	2,194	11,152	5,228	6,241	.....	a5,552	1,065	.....
1882	52,732	28,070	1,953	2,171	5,014	1,138	5,179	.....	a6,842	2,124	.....
1883	46,725	20,000	1,606	1,894	2,612	84	3,869	.....	a5,890	1,669	.....
1884	31,913	20,000	1,025	881	890	1,179	3,292	2,931	1,376	332	.....
1885	32,073	21,400	3,469	385	1,296	35	1,144	1,309	2,197	446	.....
1886	29,981	18,000	1,406	409	1,449	.....	1,949	3,478	1,769	735	.....
1887	33,825	20,000	1,490	689	1,890	.....	1,446	2,880	2,694	673	1,371
1888	33,250	18,000	1,320	126	2,164	.....	425	959	4,065	1,151	1,848
1889	26,484	13,100	980	812	2,283	.....	556	.....	4,590	1,345	1,874

a Including Ætna.

TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES—Continued.

[Flasks.]

YEARS.	Pope Valley.	Saint John.	Altoona.	Oceanic.	Oakland.	California.	Sunderland.	Cloverdale.	Abbott.	Manhattan.	Various mines.
Total	18,097	8,598	7,527	7,391	6,831	5,653	2,777	2,661	2,272	1,415	66,981
1850											
1851											
1852											4,099
1853											
1854											
1855											3,858
1856											2,862
1857											
1858											5,239
1859											11,706
1860											2,939
1861											571
1862											1,885
1863											6,876
1864	800										2,286
1865											2,261
1866											2,621
1867											3,164
1868	1,122										112
1869	1,580										
1870	1,220										
1871	1,970										840
1872	1,830										
1873	1,955										3,276
1874	1,645	1,743									
1875	1,940	1,927	533								3,747
1876	300	1,683	1,979	2,358	2,150	965	1,570	1,028	1,436	976	2,595
1877	1,060	1,463	1,317	2,575	1,395	1,516	735	1,291	836	439	1,234
1878	1,075		1,534	1,679	1,615	1,640	472	116			158
1879	1,325	1,290	1,919	779	1,505	1,110		18			101
1880	275	492	245		166	422					
1881								208			376
1882											241
1883											101
1884											7
1885											392
1886											786
1887											*a*692
1888											992
1889											*b*944

a Including 65 flasks from Oregon.

b Including 20 flasks from Oregon.

It is possible also from the existing records to present the statistics of production for every mine in each month for the last 10 years, as follows:

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS.

[Flasks.]

1880.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (*a*)	Napa. (*a*)	Great Eastern.	Bradford.	Various mines.
Total	59,926	23,465	3,209	2,139	10,706	6,670	6,442		4,416	1,279		1,600
January	4,670	1,539	203	142	760	1,000	550		205	39		232
February	4,895	1,809	96	310	965	535	565		375	110		130
March	5,977	2,155	443	239	1,286	730	565		251	210		98
April	4,261	1,667	165	103	611	645	574		161	96		239
May	5,351	1,938	226	356	1,130	560	572		315	164		90
June	5,283	1,985	269	127	819	550	585		420	142		386
July	4,189	1,688	250	135	993		540		455	118		70
August	5,260	2,360	312	189	878	340	525		455	133		68
September	4,708	2,166	245	175	687	300	452		480	122		81
October	5,275	1,858	216	166	865	1,100	557		358	57		98
November	5,748	2,238	539	96	1,209	500	467		591	42		66
December	4,309	2,062	245	101	563	410	490		350	46		42

a Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1881.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (a)	Napa. (a)	Great Eastern.	Bradford.	Various mines.
Total	60,851	26,060	2,775	2,194	11,152	5,228	6,241	.....	5,552	1,065	.....	584
January	5,861	2,259	330	140	895	1,300	451	.....	430	13	.....	43
February	4,261	2,187	171	32	635	600	399	.....	233	.....	.....	4
March	5,560	2,466	206	354	1,100	350	400	.....	505	179	.....	.....
April	5,071	2,507	158	284	706	357	447	.....	466	123	.....	23
May	4,889	1,346	200	218	1,163	500	681	.....	659	97	.....	25
June	5,564	1,780	201	196	1,403	340	801	.....	621	94	.....	68
July	5,188	2,208	110	160	1,057	255	714	.....	481	47	.....	156
August	5,350	2,260	209	190	1,139	309	585	.....	490	57	.....	120
September	4,965	2,090	212	187	1,076	201	457	.....	592	113	.....	37
October	4,965	2,223	140	165	969	400	414	.....	485	106	.....	63
November	5,232	2,572	577	180	588	375	434	.....	310	166	.....	30
December	3,945	2,162	261	88	361	250	458	.....	280	70	.....	15

1882.

Total	52,732	28,070	1,953	2,171	5,014	1,138	5,179	.....	6,842	2,124	.....	241
January	3,664	1,632	179	178	623	50	395	.....	430	144	.....	33
February	3,767	1,924	121	145	460	210	348	.....	440	98	.....	21
March	3,946	2,078	160	70	359	200	505	.....	459	91	.....	24
April	4,027	2,110	127	174	319	229	486	.....	525	57	.....	.....
May	4,611	2,446	269	211	354	13	521	.....	737	55	.....	5
June	4,167	2,318	121	131	522	30	456	.....	485	76	.....	28
July	4,381	2,522	169	195	579	.....	410	.....	380	111	.....	15
August	4,685	2,432	130	184	418	50	490	.....	582	388	.....	11
September	5,209	2,766	129	225	430	140	513	.....	641	348	.....	17
October	5,129	2,844	266	251	370	60	516	.....	580	229	.....	13
November	4,511	2,619	156	96	280	81	200	.....	718	306	.....	55
December	4,635	2,379	126	311	300	75	339	.....	865	221	.....	19

1883.

Total	46,725	29,000	1,606	1,894	2,612	84	3,869	.....	5,890	1,669	.....	101
January	4,582	2,497	112	367	280	77	390	.....	590	262	.....	7
February	3,600	2,150	133	181	310	7	364	.....	295	156	.....	4
March	3,875	2,230	142	202	335	.....	305	.....	485	162	.....	14
April	3,354	1,756	76	243	310	.....	294	.....	530	142	.....	3
May	3,768	2,344	144	135	350	.....	293	.....	325	164	.....	13
June	3,561	2,214	137	165	91	.....	400	.....	360	184	.....	10
July	4,024	2,618	85	141	130	.....	446	.....	452	150	.....	2
August	4,431	3,000	139	94	112	.....	315	.....	695	76	.....	.....
September	4,642	3,010	164	45	265	.....	297	.....	750	81	.....	30
October	4,129	2,672	272	109	206	.....	215	.....	521	134	.....	.....
November	3,488	2,212	115	78	160	.....	208	.....	613	102	.....	.....
December	3,271	2,297	87	134	63	.....	342	.....	274	56	.....	18

1884.

Total	31,913	20,000	1,025	881	890	1,179	3,292	2,931	1,376	332	.....	7
January	2,865	1,440	103	127	263	.....	373	329	135	28	.....	7
February	2,321	1,458	59	104	.....	.....	241	276	174	9	.....	.....
March	2,459	1,606	36	123	68	.....	223	249	152	2	.....	.....
April	2,709	1,785	75	50	76	.....	232	422	69	.....	.....	.....
May	2,470	1,672	125	53	200	.....	169	245	6	.....	.....	.....
June	2,694	1,859	44	118	.....	200	258	215	.....	.....	.....	.....
July	2,628	1,543	29	71	52	200	258	374	101	.....	.....	.....
August	2,912	1,804	63	47	20	306	334	228	110	.....	.....	.....
September	2,377	1,448	67	52	35	58	354	136	169	58	.....	.....
October	2,668	1,625	115	68	25	160	328	153	90	104	.....	.....
November	2,985	1,900	157	32	53	150	230	132	240	91	.....	.....
December	2,885	1,860	152	36	98	105	292	172	130	40	.....	.....

a Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1885.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa.	Great Eastern.	Bradford.	Various mines.
Total	32,073	21,400	3,469	385	1,296	35	1,144	1,309	2,197	446	.....	392
January	2,483	1,700	172	40	24	.....	190	189	131	37	.....	.....
February	2,316	1,506	245	24	85	35	70	96	180	75	.....	.....
March	2,262	1,500	314	.....	83	.....	80	88	145	33	.....	19
April	2,816	2,003	340	.....	69	.....	80	142	145	37	.....	.....
May	2,793	2,000	269	.....	194	.....	75	62	190	.....	.....	3
June	2,713	1,750	330	50	91	.....	62	112	250	63	.....	5
July	2,694	1,750	321	43	209	.....	75	45	191	50	.....	10
August	3,047	2,104	324	49	150	.....	80	118	175	.....	.....	47
September	2,978	1,936	347	57	85	.....	95	201	180	.....	.....	77
October	2,468	1,598	236	42	123	.....	85	52	185	65	.....	82
November	2,468	1,576	292	43	61	.....	122	54	190	43	.....	87
December	3,035	1,977	279	37	122	.....	130	159	235	43	.....	62

1886.

Total	29,981	18,000	1,406	409	1,449	.....	1,949	3,478	1,769	735	.....	786
January	2,398	1,431	70	42	100	.....	339	162	147	73	.....	34
February	2,103	1,100	175	24	118	.....	274	132	192	53	.....	45
March	2,425	1,522	20	21	91	.....	226	209	218	43	.....	75
April	2,293	1,256	90	36	172	.....	115	328	172	62	.....	62
May	2,381	1,600	101	18	36	.....	99	228	128	76	.....	95
June	2,722	1,806	110	19	113	.....	126	276	123	71	.....	78
July	2,601	1,572	95	24	98	.....	138	345	138	64	.....	127
August	2,202	1,240	105	35	119	.....	156	313	74	76	.....	84
September	2,108	1,210	179	30	100	.....	107	303	82	64	.....	33
October	2,390	1,280	106	50	150	.....	171	392	124	65	.....	52
November	3,232	1,900	180	76	191	.....	169	477	209	55	.....	35
December	3,126	2,083	175	34	171	.....	89	313	162	33	.....	66

1887.

Total	33,760	20,000	1,490	689	1,890	.....	1,446	2,880	2,694	673	1,371	627
January	3,077	1,904	185	51	162	.....	56	450	181	76	.....	12
February	2,408	1,700	40	.....	149	.....	86	240	150	43	.....	.....
March	2,556	1,584	95	74	110	.....	105	125	275	48	.....	140
April	2,586	1,671	105	91	157	.....	90	200	212	29	.....	31
May	2,830	2,040	50	80	126	.....	152	100	215	27	.....	40
June	2,822	1,700	170	82	127	.....	126	200	220	93	.....	104
July	2,820	1,567	125	56	175	.....	194	200	205	57	201	40
August	2,781	1,517	90	72	160	.....	108	200	275	61	220	78
September	2,923	1,535	120	26	297	.....	123	400	160	42	195	25
October	2,859	1,405	140	66	171	.....	132	300	304	64	228	49
November	2,613	1,225	214	82	113	.....	127	165	247	71	295	74
December	3,485	2,152	156	9	143	.....	147	300	250	62	232	34

1888.

Total	33,259	18,000	1,320	126	2,164	.....	625	959	4,065	1,151	3,848	992
January	3,949	2,650	118	.....	292	.....	61	246	235	84	179	84
February	2,733	1,730	82	.....	156	.....	64	195	223	79	243	51
March	2,481	1,400	90	.....	150	.....	43	95	288	108	270	37
April	2,862	1,579	110	.....	138	.....	95	143	324	153	292	28
May	3,037	1,610	125	.....	155	.....	69	226	320	80	357	95
June	2,956	1,500	120	.....	189	.....	26	94	345	110	454	118
July	2,359	1,100	120	.....	167	.....	34	50	248	94	463	83
August	2,547	1,109	110	.....	215	.....	29	.....	347	93	527	117
September	2,348	1,178	60	.....	195	.....	42	.....	370	58	357	88
October	2,635	1,269	185	36	180	.....	47	.....	440	88	294	96
November	2,604	1,400	90	30	176	.....	28	.....	475	82	220	103
December	2,739	1,475	110	60	151	.....	87	.....	450	122	192	92

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1889.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Etna.	Napa.	Great Eastern.	Bradford.	Various mines.
Total	26,464	13,100	980	812	2,283	.....	556	.....	4,590	1,345	1,874	924
January	2,337	1,200	65	.....	173	.....	81	.....	385	94	230	109
February	1,813	820	65	.....	173	.....	45	.....	400	76	182	52
March	2,217	1,290	70	.....	175	.....	34	.....	380	89	116	63
April	2,203	1,249	70	.....	215	.....	30	.....	320	92	119	108
May	2,085	870	70	206	192	.....	.....	.....	445	97	132	73
June	2,218	950	75	117	235	.....	.....	.....	415	211	152	63
July	2,066	966	70	124	211	.....	41	.....	340	135	110	69
August	2,223	1,000	70	64	216	.....	17	.....	450	168	170	68
September	2,073	970	75	73	224	.....	97	.....	360	77	136	61
October	2,453	1,300	80	89	164	.....	70	.....	385	87	214	64
November	2,492	1,300	130	139	150	.....	89	.....	380	107	134	72
December	2,284	1,185	140	.....	155	.....	61	.....	330	112	179	122

In collecting the data for the world's production of quicksilver every effort was made to obtain some reliable statistics of the production of quicksilver in Mexico and China, but without success at the time of making this report.

THE WORLD'S PRODUCTION OF QUICKSILVER FOR 10 YEARS. (*a*)

YEARS.	Total supply.	California.	SPAIN.		AUSTRIA-HUNGARY.		Italy.	Russia.	Estimated consumption.	Estimated stock in London, England.
			Almaden.	Various. (*b*)	Idria.	Various. (*c*)				
Total	1,146,741	*d*407,675	485,939	16,273	135,403	8,808	*e*75,704	16,939	1,142,890	.....
1880	122,536	59,926	45,322	(*f*)	12,356	712	4,220	.....	95,600	68,500
1881	122,678	60,851	44,989	(*f*)	11,333	720	4,785	.....	106,300	84,899
1882	119,394	52,732	46,716	2,795	11,663	588	4,900	.....	116,200	88,000
1883	118,858	46,725	49,177	2,165	13,152	709	6,930	.....	124,800	82,014
1884	105,430	31,913	48,098	2,219	13,967	733	8,500	.....	111,300	76,105
1885	101,748	32,073	45,813	2,046	13,503	773	7,549	.....	108,300	69,467
1886	107,588	29,981	51,199	2,277	14,496	1,400	8,235	.....	123,050	54,000
1887	116,711	33,760	53,276	2,894	14,676	1,030	9,220	1,855	131,700	39,000
1888	117,956	33,250	51,872	1,877	14,962	1,018	10,200	4,777	109,900	47,099
1889	113,842	26,464	49,477	(*f*)	15,295	*g*1,125	11,174	10,307	115,740	45,199

a In the United States the flask contains 76.5 pounds avoirdupois, or 34.7 kilograms; in Spain, Austria-Hungary, Italy, Russia, and elsewhere, only 34.5 kilograms.

b Comprises mines in the provinces of Oviedo, Granada, and Cuidad Real.

c Comprises mines in Carniola and Hungary.

d In 1887 Oregon produced 65 flasks and in 1889 20 flasks, which are not included in this total.

e Figures taken from monograph on the quicksilver mines of Monte Amiata, by Mr. P. de Ferrari, M. E., 1889.

f Quantities unknown.

g Comprises mines in Carniola only, the production of Hungary not being known.

The following table is published simply to show the various statistics which have appeared as to the production of quicksilver in Italy:

VARIOUS STATEMENTS AS TO THE PRODUCTION OF QUICKSILVER IN ITALY.

[Flasks.]

YEARS.	PRODUCTION.		
	Letter from Rome. (a)	De Ferrari's table. (b)	De Ferrari's table. (c)
Total	67,726.9	66,689.4	75,704
1880	3,314.3	3,343.1	4,220
1881	4,755.3	3,689.0	4,785
1882	4,034.8	4,034.8	4,909
1883	5,936.9	5,936.9	6,930
1884	7,694.9	7,694.9	8,500
1885	6,830.3	6,830.3	7,540
1886	7,233.8	7,233.8	8,235
1887	7,032.1	7,032.1	9,220
1888	9,770.0	9,770.0	10,200
1889	11,124.5	11,124.5	11,174

a Letter from D'Amiani, under secretary of state of his majesty's foreign affairs at Rome, dated August 8, 1890.

b From table, page 145, of P. de Ferrari's monograph "Le miniere di mercurio del Monte Amiata".

c From table, page 146, of same, giving production of Monte Amiata in flasks.

PRICES PER FLASK OBTAINED IN NEW YORK FOR CALIFORNIA QUICKSILVER IN 1889.

MONTHS.	Prices obtained in New York.	Netting in San Francisco, freight and drayage $1.30.	Rothschild's quotation and equivalent for quicksilver laid down in New York, duty added.		Laid down in New York, duty added.	London outsiders' price.	
			£	s. d.		£	s. d.
January—							
Highest	$44.00	$42.70	9	10 0	$50.50	$46.60	8 15 0
Lowest	43.00	41.70	9	10 0	50.50	43.55	8 3 6
February—							
Highest	43.25	41.95	8	10 0	45.25	43.40	8 3 0
Lowest	40.00	38.70	7	10 0	40.00	39.30	7 7 6
March—							
Highest	40.50	39.20	7	15 0	41.25	41.40	7 15 6
Lowest	39.00	37.70	7	10 0	40.00	39.30	7 7 6
April—							
Highest	42.00	40.70	8	0 0	42.60	42.60	8 0 0
Lowest	40.00	38.70	7	12 6	40.60	40.60	7 12 6
May—							
Highest	45.25	43.95	8	10 0	45.25	44.35	8 6 6
Lowest	42.75	41.45	8	5 0	44.00	41.85	7 17 0
June—							
Highest	48.00	46.70	9	10 0	50.50	47.70	8 19 0
Lowest	43.00	46.70	8	15 0	46.60	43.55	8 3 6
July—							
Highest	49.00	47.70	9	15 0	51.75	50.20	9 8 6
Lowest	46.00	44.70	9	10 0	50.50	46.60	8 15 0
August—							
Highest	49.00	47.70	9	15 0	51.75	49.95	9 7 6
Lowest	43.00	46.70	9	15 0	51.75	48.90	9 3 6
September—							
Highest	49.50	48.20	9	15 0	51.75	49.15	9 4 6
Lowest	48.50	47.20	9	15 0	51.75	48.75	9 3 0
October—							
Highest	49.00	47.70	9	5 0	49.30	49.30	9 5 0
Lowest	48.50	47.20	9	5 0	49.30	47.30	8 17 6
November—							
Highest	50.00	48.70	9	15 0	51.75	50.90	9 11 0
Lowest	49.00	47.70	9	10 0	50.50	49.95	9 7 6
December—							
Highest	50.00	48.70	9	15 0	51.75	50.35	9 9 0
Lowest	48.50	47.20	9	15 0	51.75	49.30	9 5 0

MONTHLY QUOTATIONS PER FLASK FOR QUICKSILVER AT SAN FRANCISCO FROM 1880 TO 1889, INCLUSIVE.

MONTHS.	1880.		1881.		1882.		1883.		1884.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$34.45	$28.30	$28.30	$27.90	$28.50	$28.30	$26.75	$26.00	$26.25	$26.00
February	34.45	28.30	29.85	28.30	28.50	28.10	27.25	26.00	29.00	26.00
March	34.45	29.85	29.05	27.90	28.50	28.10	28.00	26.75	29.00	28.00
April	30.60	29.85	29.85	28.70	29.05	28.50	27.00	26.75	29.00	28.00
May	30.60	29.85	28.90	28.50	29.10	28.70	27.00	26.75	29.00	29.00
June	30.60	27.55	28.70	28.50	28.70	28.50	28.50	26.75	29.00	29.00
July	30.60	27.90	29.05	28.50	28.50	28.30	28.50	27.50	29.00	28.75
August	34.45	29.45	29.05	28.30	28.50	28.30	27.50	26.25	30.00	28.75
September	30.60	30.25	28.50	28.10	28.90	28.30	26.75	26.25	31.00	30.00
October	30.25	29.45	31.75	29.05	28.90	28.30	26.50	26.50	30.50	29.00
November	29.85	29.45	31.75	29.85	28.50	28.10	26.50	26.00	34.00	29.00
December	29.45	27.90	28.90	27.90	27.90	27.35	26.25	26.00	35.00	32.00
Extreme range	34.45	27.55	31.75	27.90	29.10	27.35	28.50	26.00	35.00	26.00

MONTHS.	1885.		1886.		1887.		1888.		1889.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$33.00	$32.50	$32.50	$32.00	$38.75	$38.50	$48.00	$42.00	$43.00	$41.50
February	32.50	32.50	32.50	32.50	38.75	38.50	43.00	39.00	42.00	41.50
March	32.50	31.00	33.00	32.50	38.50	37.00	40.00	38.50	41.50	40.00
April	31.00	30.00	33.00	33.00	40.00	37.50	38.50	38.00	41.50	40.00
May	29.00	28.50	34.00	33.00	38.00	37.50	38.00	37.25	45.00	41.00
June	30.00	29.00	36.00	34.00	39.00	38.00	38.00	37.25	50.00	46.50
July	30.00	29.75	37.00	36.00	38.00	37.50	37.50	37.00	47.50	46.00
August	29.75	29.50	37.00	36.75	37.00	36.50	37.25	37.00	47.50	46.00
September	30.50	29.50	37.00	36.50	38.00	36.50	43.00	37.00	47.50	47.00
October	30.50	30.00	39.00	38.75	39.00	37.00	44.00	43.00	47.00	46.50
November	30.00	29.75	38.75	38.50	40.00	37.00	43.00	42.50	48.00	46.00
December	32.00	30.00	38.75	38.50	48.00	45.00	43.00	41.00	47.50	47.00
Extreme range	33.00	28.50	39.00	32.00	48.00	36.50	48.00	37.00	50.00	40.00

HIGHEST AND LOWEST PRICES PER FLASK OF QUICKSILVER DURING THE PAST 40 YEARS IN SAN FRANCISCO AND LONDON.

YEARS.	SAN FRANCISCO.		LONDON.				YEARS.	SAN FRANCISCO.		LONDON.			
	Highest.	Lowest.	Highest.			Lowest.		Highest.	Lowest.	Highest.			Lowest.
			£	s.	d.	£ s. d.				£	s.	d.	£ s. d.
1850	$114.75	$84.15	15	0	0	13 2 6	1871	$68.85	$57.35	12	0	0	9 0 0
1851	76.50	57.35	13	15	0	12 5 0	1872	66.95	65.00	13	0	0	10 0 0
1852	61.20	55.45	11	10	0	9 7 6	1873	91.80	68.85	20	0	0	12 0 0
1853	55.45	55.45	8	15	0	8 2 6	1874	118.55	91.80	26	0	0	19 0 0
1854	55.45	55.45	7	15	0	7 5 0	1875	118.55	49.75	24	0	0	9 17 6
1855	55.45	51.65	6	17	6	6 10 0	1876	53.55	34.45	12	0	0	7 17 6
1856	51.65	51.65	6	10	0	6 10 0	1877	44.00	30.60	9	10	0	7 2 6
1857	53.55	45.90	6	10	0	6 10 0	1878	35.95	29.85	7	5	0	6 7 6
1858	49.75	45.90	7	10	0	7 5 0	1879	34.45	25.25	8	15	0	5 17 6
1859	76.50	49.75	7	5	0	7 0 0	1880	34.45	27.55	7	15	0	6 7 6
1860	57.35	49.75	7	0	0	7 0 0	1881	31.75	27.90	7	0	0	6 2 6
1861	49.75	34.45	7	0	0	7 0 0	1882	29.10	27.35	6	5	0	5 15 0
1862	38.25	34.45	7	0	0	7 0 0	1883	28.50	26.00	5	17	6	5 5 0
1863	45.90	38.25	7	0	0	7 0 0	1884	35.00	26.00	6	15	0	5 2 6
1864	45.90	45.90	9	0	0	7 10 0	1885	33.00	28.50	6	15	0	5 2 6
1865	45.90	45.90	8	0	0	7 17 6	1886	39.00	32.00	7	10	0	5 16 3
1866	57.35	45.90	8	0	0	6 17 6	1887	48.00	36.50	11	5	0	6 7 6
1867	45.90	45.90	7	0	0	6 16 0	1888	48.00	37.00	10	0	0	7 0 0
1868	45.90	45.90	6	17	0	6 16 0	1889	50.00	40.00	9	15	0	7 10 0
1869	45.90	45.90	6	17	0	6 16 0							
1870	68.85	45.90	10	0	0	6 16 0	Extreme range in 40 years.	118.55	25.25	26	00	0	5 2 6

HIGHEST AND LOWEST PRICES PER FLASK PREVAILING AT HONGKONG FOR QUICKSILVER, BY MONTHS AND YEARS, FOR THE DECADE 1880–1889. (*a*)

MONTHS.	1880.		1881.		1882.		1883.		1884.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$59.75	$59.00	$56.75	$56.25	$58.25	$57.25	$56.50	$55.25	$53.00	$52.00
February	65.00	59.00	58.25	57.75	57.50	57.00	56.25	55.00	53.80	52.00
March	62.50	59.50	57.50	57.00	58.00	57.50	57.00	55.75	55.00	52.50
April	62.25	59.75	59.50	58.00	57.75	56.50	56.25	55.75	56.00	54.75
May	60.50	58.25	58.50	57.75	57.50	56.75	56.00	55.75	56.50	54.75
June	58.75	55.75	59.00	57.50	57.25	56.00	56.50	56.25	55.00	52.25
July	57.50	55.75	58.50	58.00	56.00	55.75	57.25	56.00	53.40	51.75
August	60.50	57.75	58.25	57.50	57.25	56.50	56.50	56.00	52.00	51.00
September	61.75	60.25	57.75	57.00	57.25	57.00	55.75	54.50	52.00	51.50
October	60.50	58.75	58.50	58.00	57.25	57.00	54.00	52.75	54.50	52.00
November	58.75	57.75	58.50	58.00	57.50	57.25	54.50	52.75	62.00	54.00
December	57.50	56.20	58.75	58.00	57.50	56.50	54.00	53.00	69.00	62.50

MONTHS.	1885.		1886.		1887.		1888.		1889.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$68.00	$67.00	$66.00	$64.00	$83.00	$79.00	$115.00	$92.00	$100.00	$93.50
February	67.50	66.50	66.50	65.75	83.50	81.50	95.00	94.00	96.00	94.00
March	67.50	59.00	66.00	65.00	83.50	82.50	90.00	88.00	93.00	90.00
April	61.00	59.00	65.00	64.50	83.00	82.00	88.00	85.50	94.50	93.00
May	59.50	58.00	66.00	65.50	82.50	78.00	85.00	81.00	95.00	93.50
June	61.00	58.00	75.00	67.50	.....	78.00	93.00	92.00	100.50	94.00
July	60.00	57.50	81.00	74.00	80.50	80.00	92.50	91.00	116.00	101.00
August	62.50	59.50	82.50	82.00	83.00	79.00	92.00	88.50	115.00	102.00
September	63.00	59.75	82.00	81.00	85.50	85.00	99.50	96.00	111.00	107.00
October	62.50	60.75	84.50	84.00	88.50	87.00	101.00	97.00	106.00	103.00
November	62.00	59.50	82.50	78.50	89.00	87.50	99.50	99.00	107.50	106.00
December	66.50	64.50	78.00	77.00	115.00	103.00	97.00	96.00	108.00	105.00

a During which time the lowest price reached was in August, 1884, $51 to $52, and the highest in July, 1889, $101 to $116.

DISTRIBUTION OF QUICKSILVER.

TOTAL EXPORTS AND SHIPMENTS OF QUICKSILVER IN 1889.

BY SEA.	FLASKS.	
To Mexico	4,593	
To Central America	47	
To Chile and South America	10	
To New Zealand	112	
To Australia	10	
To British Columbia	11	
	4,783	
Shipments to New York	430	
Total by sea		5,213
BY RAILROAD.		
From San Jose, California:		
To New York	5,100	
To Texas	200	
To Montana	1,995	
To Utah	118	
To Idaho	100	
To Arizona	90	
	7,603	
From San Francisco, California:		
To New York	1,500	
To Mexico	819	
To Montana, Idaho, and Utah	2,311	
To Arizona	110	
To Colorado	61	
	4,801	
From San Francisco, via Portland and Northern Pacific railroad, to Montana	350	
Add for shipments to Montana, Idaho, and Arizona not included in above	533	
Total by railroad		13,287
Total shipments by sea and railroad		18,500

SHIPMENTS OF QUICKSILVER IN BOND FROM SAN FRANCISCO. (a)

YEARS.	Spanish, in bond to—	Flasks.	Value.
Total		1,100	$36,619
1886	Mexico	500	13,719
1887	Hongkong	500	18,300
1889	Mexico	100	4,600

a Reported by the San Francisco customhouse.

SHIPMENTS OF QUICKSILVER OVERLAND TO POINTS EAST FOR THE 10 YEARS ENDED DECEMBER 31, 1889, VIA THE CENTRAL PACIFIC RAILROAD. (a)

	FLASKS.		FLASKS.
1880	15,553	1885	9,096
1881	13,555	1886	8,039
1882	7,996	1887	5,859
1883	5,211	1888	3,622
1884	2,830	1889	6,889

a Compiled from annual reports of the San Francisco Journal of Commerce.

IMPORTS.

The following table, compiled from the records of the bureau of statistics of the Treasury department, shows the amounts of quicksilver reported by the collectors of customs as imported in each year for 10 years. The original figures are reported in pounds, and sometimes include the weight of the iron flask. The importations in 1890 increased materially, amounting to 10,482 flasks, valued at $445,857.

QUICKSILVER IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1880 TO 1889, INCLUSIVE.

YEARS ENDING—	Flasks.	Value.
June 30, 1880	1,296	$48,463
1881	1,539	57,733
1882	6,643	233,057
1883	17,253	593,367
1884	1,518	44,035
1885	2,866	90,416
Dec. 31, 1886	4,468	142,325
1887	7,706	290,380
1888	1,730	56,997
1889	4,464	162,064

IMPORT DUTIES AND EXPORTS.

The following is a comparative statement of the rates of import duty on quicksilver under the several tariff acts from July 30, 1846, to October 1, 1890, both inclusive:

IMPORT DUTIES ON QUICKSILVER.

Act of—			Act of—		
July 30, 1846	per cent	20	March 2, 1867	per cent	15
March 3, 1857	do	15	March 22, 1867	do	15
March 2, 1861	do	10	March 25–26, 1867	do	15
August 5, 1861	do	10	March 29, 1867	do	15
December 24, 1861	do	10	February 3, 1868	do	15
July 14, 1862	do	10	July 20, 1868	do	15
March 3, 1863	do	10	February 19–24, 1869	do	15
June 30, 1864	do	10 and 15	July 14, 1870	do	15
March 3, 1865	do	10 and 15	December 22, 1870	do	15
March 16, 1866	do	10 and 15	May 1, 1872	per cent of existing duties	90
May 16, 1866	do	10 and 15	June 6, 1872	do	90
June 1, 1866	do	10 and 15	March 3, 1883	per cent	10
July 28, 1866	do	15	October 1, 1890	cents per pound	10

Under the tariff act of October 1, 1890, the flasks, bottles, or other vessels in which quicksilver may be imported are subjecet to the same rate of duty as they would be if imported empty. Quicksilver flasks or bottles of either domestic or foreign manufacture which have been actually exported from the United States are entitled to free entry.

CUSTOMS DUTIES IMPOSED BY FOREIGN NATIONS UPON AMERICAN QUICKSILVER. (a)

Brazil.....$5.70 per 100 pounds.
China.....$2.60 per 133.3 pounds
Corea.....7.5 per cent ad valorem.
Ecuador.....$8.52 per 100 pounds.
Greece.....73 cents per 100 pounds.
Hawaiian Islands.....10 per cent ad valorem.
Haiti.....20 per cent ad valorem.
Honduras.....$1.66 for 104 pounds.
Italy—Quicksilver.....$1.93 for 220,464 pounds.
Oxide of mercury, muriate of mercury, chloride of mercury, precipitate of mercury.....$0.77 for 220.464 pounds.
Calomel.....$23.16 for 220.464 pounds.
Vermilion.....$4.83 for 220.464 pounds.
Japan.....$1.58 for 131 pounds.
New South Wales.....5 per cent ad valorem.
Peru.....10 per cent ad valorem.
Porto Rico.....$2.72 for 220.464 pounds.
Russia.....$1.20 for 36 pounds.
San Salvador.....5 per cent ad valorem.
Spain.....31 cents for 220.464 pounds.
Sweden.....$4.76 for 100 pounds.
Switzerland.....58 cents for 110 pounds.
Turkey.....$7.04 for 220 pounds.
United States of Colombia.....$9.90 per 100 pounds.
Uruguay.....47 per cent ad valorem.
Venezuela.....$11.05 for 100 pounds.

a The report is taken from United States consular report No. 73½, Washington, 1887; all in United States weight and currency.

EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES FOR THE 10 YEARS ENDED DECEMBER 31, 1889.

[Compiled from the returns sent in by the various collectors of customs.]

PORTS.	TOTAL.		1880.		1881.		1882.		1883.	
	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.
Total	183,716	5,617,685	37,210	1,119,952	35,107	1,025,299	33,875	988,454	30,072	808,353
Ports from which exported—										
San Francisco	176,974	5,378,118	34,359	1,028,826	33,935	985,927	33,728	983,977	29,928	804,077
New York	6,666	223,049	2,221	76,244	1,166	39,161	143	4,344	137	4,037
Philadelphia	630	14,882	630	14,882	.....	.....	.....	.....	.....	.....
Boston	40	1,454	.....	.....	6	211	4	133	7	239
New Orleans	6	182	.....	.....	.....	.....	.....	.....	.....	.....
Total	183,716	5,617,685	37,210	1,119,952	35,107	1,025,299	33,875	988,454	30,072	808,353
Exported to—										
Hongkong	79,451	2,371,108	19,610	577,019	17,031	493,171	18,965	560,353	16,356	438,689
Central American States	2,594	94,294	41	1,095	38	1,086	75	2,151	150	4,263
Chile	3,543	105,309	754	24,842	123	3,700	1,400	42,000	1,150	31,250
China	87	2,861	50	1,475	.....	.....	.....	.....	.....	.....
Germany	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
England	2,553	96,082	1,753	59,882	.....	.....	.....	.....	.....	.....
British Columbia	205	6,406	7	211	5	141	16	472	4	110
British possessions in Australasia	6,332	190,638	1,535	47,874	1,330	37,249	1,831	52,997	786	20,766
Japan	3,344	88,705	105	3,050	314	9,213	621	17,601	1,297	32,151
Mexico	82,172	2,558,030	12,413	376,007	15,256	450,448	10,128	288,441	10,157	276,332
Peru	1,955	57,231	440	13,540	700	20,161	665	19,285	100	2,695
Cuba	377	11,083	356	10,270	.....	.....	1	33	.....	.....
United States of Colombia	581	19,118	115	3,673	208	6,487	45	1,280	11	326
Venezuela	333	10,694	13	497	90	3,225	98	2,941	36	1,028
Dutch Guiana	37	1,399	1	26	12	418	4	133	5	175
Nova Scotia, New Brunswick, and Prince Edward Island.	23	905	.....	.....	.....	.....	.....	.....	2	64
West Indies	55	1,629	.....	.....	.....	.....	18	552	18	504
All other ports	74	2,193	17	491	.....	.....	8	215	.....	.....

EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES, ETC.—Continued.

PORTS.	1884.		1885.		1886.		1887.		1888.		1889.	
	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.
Total	7,370	199,685	6,802	209,758	6,091	204,956	11,394	441,112	10,634	406,399	5,111	213,717
Ports from which exported—												
San Francisco	7,037	189,420	6,547	200,739	5,845	196,384	10,401	396,316	10,145	381,707	5,049	210,745
New York	332	10,233	242	8,578	240	8,340	984	44,448	539	24,692	62	2,972
Philadelphia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Boston	.....	.....	8	291	6	232	9	348	.....	.....	.....	.....
New Orleans	1	32	5	150	.....	.....	.....	.....	.....	.....	.....	.....
Total	7,370	199,685	6,802	209,758	6,091	204,956	11,394	441,112	10,634	406,399	5,111	213,717
Exported to—												
Hongkong	220	6,750	233	8,990	.....	.....	3,323	141,257	3,713	144,899	.....	.....
Central American States	285	8,390	238	8,341	164	5,805	177	6,466	1,333	52,586	93	4,111
Chile	.....	.....	104	3,042	.....	.....	.....	.....	.....	.....	12	475
China	.....	.....	.....	.....	.....	.....	.....	.....	37	1,386	.....	.....
Germany	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
England	.....	.....	.....	.....	.....	.....	800	36,200	.....	.....	.....	.....
British Columbia	15	406	40	1,088	59	1,902	31	1,104	16	548	12	424
British possessions in Australasia	130	3,768	75	2,257	90	3,295	100	3,965	322	12,979	133	5,488
Japan	669	16,032	300	9,100	3	108	.....	.....	35	1,450	.....	.....
Mexico	5,830	157,758	5,777	175,828	5,678	190,461	6,920	250,514	5,172	190,013	4,841	202,223
Peru	50	1,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cuba	11	351	.....	.....	5	180	.....	.....	2	127	2	122
United States of Colombia	80	2,376	14	498	22	873	32	1,196	48	2,096	6	313
Venezuela	36	1,057	.....	.....	60	1,946	.....	.....	.....	.....	.....	.....
Dutch Guiana	.....	.....	5	176	2	77	3	129	5	265	.....	.....
Nova Scotia, New Brunswick, and Prince Edward Island.	.....	.....	2	76	6	232	7	261	.....	.....	6	272
West Indies	18	529	.....	.....	1	44	.....	.....	.....	.....	.....	.....
All other ports	26	718	14	362	1	33	1	40	1	59	6	234

ENGLISH QUICKSILVER MOVEMENTS.

The control of the quicksilver market is usually affected by the transactions in London, a résumé of which is given in the following tables, which show a synopsis of the statistical features of each of the past 10 years. The shipments of quicskilver to the United States are also shown.

EXPORTS OF QUICKSILVER FROM ENGLAND.

[Flasks.]

EXPORTED TO—	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	16,023	24,889	40,424	49,006	52,548	48,865	66,109	62,606	47,123	57,604
Russia	1,117	1,539	1,451	1,156	769	1,595	1,031	399	45	72
Germany	2,504	2,059	2,974	3,906	2,224	2,916	3,557	3,542	4,098	3,278
Holland	692	708	941	702	819	843	853	1,254	633	1,323
Belgium	285	742	779	868	729	507	816	608	725	.....
Channel Islands	127	70	131	75	85	142	118	97	40	67
France	3,997	6,143	6,871	5,083	4,492	6,854	4,553	7,718	4,884	8,995
Portugal	465	530	452	444	442	609	445	447	.....	.....
Spain	47	51	21	97		.....	.....		475	412
Turkey	24	79	93	123	85	136	97	46	33	42
Roumania and Bulgaria	.....	24	.....	.....	.....	.....	.....	.....	.....	.....
Roumania and Greece	.....	.....	.....	.....	26	.....	.....	.....	.....	.....
Morocco	.....	.....	3	.....	.....	9	12	.....	11	.....
Persia	.....	.....	.....	.....	4	.....	.....	.....	.....	.....
Gold Coast	5	16	77	131	52	.....	49	33	77	.....
South Australia	5	11	150	.....	.....	20	.....	.....	.....	.....
Natal	.....	.....	.....	.....	302	94	.....	.....	.....	.....
Cape of Good Hope	.....	.....	.....	.....	60	.....	.....	.....	.....	.....
Natal and Cape of Good Hope	.....	.....	.....	.....	.....	.....	194	971	742	239
United States	200	4,659	13,116	14,382	4,871	5,112	12,311	10,554	4,649	7,967
Dutch West Indies	22	60	64	87	234	76	.....	.....	200	4
Mexico	2,631	5,043	5,562	5,120	5,551	5,680	10,592	6,545	9,967	6,168
Central America	370	230	122	233	217	156	188	124	253	197
United States of Colombia	.....	333	238	202	408	409	63	221	180	620
Canary Islands	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Peru	936	970	2,147	2,198	1,767	2,276	3,188	2,025	2,389	4,430
Brazil	67	22	59	216	189	212	173	126	189	.....
Argentine Republic	1,877	331	2,083	1,591	850	339	114	148	416	434
Norway	4	2								
Denmark	31	46	94	88	92	48	49	104	78	42
Sweden	35	32								
Italy	31	79	33	52	40	15	11	27	8	76
Egypt	25	37	19	10	55	1	16	15	.....	154
Bengal	.....	50	392	2,750	920	953	1,498	1,559	1,506	.....
Java	.....	.....	.....	.....	40	.....	.....	.....	.....	.....
Java and Ceylon	.....	.....	.....	.....	.....	5	.....	.....	.....	.....
Victoria	42	162	390	134	75	886	194	826	457	1
New Zealand	37	61	61	80	54	28	34	216	176	69
Chile	314	298	647	1,496	1,308	2,085	2,297	2,625	1,442	.....
Japan	.....	.....	.....	.....	750	10	810	.....	334	1,006
China	.....	12	10	1,301	10	.....	.....	.....	.....	.....
Hongkong	.....	.....	.....	4,509	23,924	14,054	21,515	19,208	10,267	16,807
Bombay	75	15	730	.....	868	1,527	869	1,551	1,570	.....
Madras	11	392	1	.....	12	55	36	63	.....	3,585
Bombay and Madras	.....	.....	.....	1,707	.....	.....	.....	.....	.....	.....
Canada	1	3	11	.....	41	23	19	332	13	81
Newfoundland	.....	.....	.....	.....	.....	.....	2	.....	.....	.....
British Burmah	.....	25	31	94	12	.....	.....	.....	.....	.....
Uruguay	34	.....	8	.....	5	9	10	10	154	.....
Spanish West Indies	.....	.....	500	.....	1	.....	69	.....	.....	.....
New South Wales	12	57	.....	112	82	716	29	435	244	1,535
Queensland	.....	4	.....	59	82	465	297	619	873	.....
Queensland and New South Wales	.....	.....	163	.....	.....	.....	.....	.....	.....	.....
Philippine Islands	.....	.....	.....	.....	.....	.....	.....	6	.....	.....
Bolivia	.....	.....	.....	.....	.....	.....	.....	152	.....	.....

ENGLISH IMPORTS AND EXPORTS OF QUICKSILVER FOR 10 YEARS, BY MONTHS.

IMPORTS.

[Flasks.]

MONTHS.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	49,544	56,259	45,036	54,521	59,969	55,154	58,967	61,114	73,768	67,529
January	6,692	8,680	7,608	362	4,617	4,350	4,496	9,404	11,440	7,250
February	16,380	4,187	4,300	3,270	5,127	4,603	12,488	9,641	10,750	8,546
March	4,117	12,211	7,947	8,300	20,327	8,434	7,179	4,180	13,844	6,591
April	7,778	5,310	10,607	4,082	7,087	329	6,036	11,752	7,960	12,630
May	6,118	5,600	4,546	11,602	9,055	9,545	10,436	4,200	4,237	1,857
June	2,173	9,487	6,490	6,482	4,628	21,328	9,130	11,700	14,902	15,266
July	504	368	.....	18,266	3,802	427	4,458	4,754	300	2,479
August	891	600	1,178	529	1,283	1,607	1,289	1,200	26	1,035
September	1,400	.....	600	550	500	300	850	510	1,670	3,329
October	2,111	600	960	218	1,340	2,057	1,201	1,298	646	944
November	1,080	527	.....	410	800	474	1,004	275	1,273	1,705
December	300	8,689	800	450	1,403	1,700	400	2,200	6,720	5,897

EXPORTS.

MONTHS.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	16,023	24,889	40,424	49,006	52,548	48,865	66,109	62,606	47,133	57,604
January	1,288	2,079	1,947	5,192	4,410	2,524	3,793	5,973	2,181	4,492
February	713	1,165	2,387	4,009	4,912	3,914	4,906	3,232	1,573	4,481
March	1,075	2,136	3,382	3,348	3,412	3,916	10,273	4,866	2,411	7,756
April	1,265	2,126	3,417	4,658	2,035	2,983	8,842	6,375	4,185	8,749
May	985	2,540	2,558	4,407	6,305	3,204	5,556	4,053	11,917	5,295
June	2,252	1,414	4,951	4,604	5,926	4,915	6,655	7,470	5,867	2,238
July	1,367	1,323	2,809	3,718	5,646	3,123	4,371	8,244	3,248	2,483
August	794	2,135	4,187	2,342	3,153	6,488	3,951	6,245	3,307	5,375
September	1,583	2,406	2,772	3,242	3,734	9,642	8,055	3,366	3,714	4,621
October	911	2,042	3,371	4,253	3,071	2,366	2,542	4,320	1,333	4,714
November	1,963	2,576	4,260	6,069	4,335	1,943	3,310	6,117	4,142	2,523
December	1,827	2,947	4,383	3,164	5,609	3,847	3,855	2,345	3,195	4,877

LONDON PRICES PER FLASK OF QUICKSILVER.

1880.

DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.
January 3	6 10 0	January 9	7 7 6	February 11	7 0 0	July 13	7 2 6	August 4	7 5 0
January 5	6 17 6	January 14	7 0 0	February 21	7 2 6	July 13	7 5 0	August 16	7 0 0
January 5	7 0 0	January 14	6 17 6	February 23	7 10 0	July 17	7 5 0	September 22	6 17 6
January 6	7 15 0	January 22	7 5 0	March 8	7 0 0	July 17	7 2 6	November 3	6 15 0
January 6	7 7 6	January 22	7 10 0	April 7	6 15 0	July 17	7 0 0	November 23	6 10 0
January 6	7 12 6	January 29	7 7 6	May 25	6 10 0	July 23	6 17 6	December 22	6 7 6
January 9	7 10 0	January 29	7 5 0	June 23	6 15 0	July 23	6 15 0		

1881.

January 7	6 10 0	March 22	6 10 0	May 19	6 5 0	September 26	6 10 0	November 15	6 5 0
January 31	6 15 0	April 4	6 5 0	July 5	6 7 6	October 11	6 15 0	November 22	6 7 0
February 8	7 0 0	April 26	6 7 6	July 7	6 10 0	October 13	7 0 0	November 23	6 10 0
March 3	6 15 0	April 27	6 10 0	August 12	6 5 0	November 7	6 10 0	December 1	6 5 0
March 3	6 13 9	May 7	6 7 6						

1882.

January 1	6 5 0	April 18	6 5 0	June 6	5 18 9	September 9	6 0 0	November 14	5 16 9
January 24	6 0 0	May 15	6 0 0	July 18	5 17 6	October 23	5 17 6	December 29	5 15 0
March 18	5 17 6	June 1	5 17 6						

LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

1883.

DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.
January 4	5 10 0	February 17	5 17 6	April 3	5 12 6	July 13	5 10 0	October 1	5 5 0
February 14	5 12 6	March 13	5 15 0	April 28	5 10 0	July 20	5 12 6	November 19	5 7 6
February 15	5 15 0	March 20	5 10 0	June 21	5 7 6	August 28	5 7 6	December 20	5 5 0

1884.

February 2	5 2 6	May 27	5 7 6	July 24	5 6 3	November 12	5 17 6	November 20	6 10 0
February 23	5 5 0	June 10	5 3 6	August 18	5 7 6	November 17	6 0 0	November 21	6 15 0
February 29	5 10 0	June 23	5 5 0	August 27	5 10 0	November 18	6 5 0	November 29	6 15 0
March 6	5 12 6	July 3	5 7 6	September 17	5 12 0	November 19	6 7 6	November 29	6 17 6
April 1	5 10 0	July 22	5 5 0	November 10	5 15 0				

1885.

March 13	6 0 0	May 13	5 12 6	August 7	5 15 0	November 9	5 17 6	November 20	6 0 0
March 13	6 15 0	June 1	5 15 0	August 11	5 17 6	November 11	5 16 3	November 23	6 3 6
April 30	5 12 6	June 2	6 0 0	September 14	6 0 0	November 19	5 17 6	November 24	6 5 0
May 5	5 10 0	July 20	5 12 6	September 17	6 2 6				

1886.

January 4	6 0 0	March 8	5 16 3	April 30	6 5 0	July 7	7 0 0	September 21	7 5 0
January 21	5 17 6	March 10	5 17 6	May 14	6 10 0	September 6	6 16 0	September 23	7 10 0
January 22	6 0 0	April 5	5 16 3	June 4	6 15 0	September 13	7 0 0	November 16	7 2 6
February 23	5 17 6	April 7	6 0 0	June 10	6 17 6	September 20	7 2 6	November 18	7 5 0
March 1	5 15 0								

1887.

January 1	7 5 0	May 23	6 10 0	August 9	7 5 0	November 30	9 5 0	December 9	9 10 0
January 6	7 7 6	May 24	6 12 6	August 29	7 10 0	November 30	9 15 0	December 10	9 15 0
March 11	7 2 6	June 17	6 11 0	October 1	7 12 6	December 1	10 5 0	December 10	10 5 0
March 14	7 0 0	June 23	6 12 6	October 10	7 15 0	December 2	10 10 0	December 10	10 10 0
March 26	6 17 6	July 7	6 15 0	November 29	8 0 0	December 6	10 10 0	December 12	11 5 0
March 28	7 0 0	July 11	6 17 6	November 30	9 0 0	December 6	10 5 0	December 12	11 0 0
May 2	6 17 6	August 8	7 0 0						

1888.

January 5	10 0 0	February 21	8 10 0	May 10	6 15 0	July 17	7 7 6	September 15	8 12 6
January 14	9 5 0	March 6	8 2 6	May 23	7 2 6	July 17	7 7 6	September 15	8 15 0
January 17	9 10 0	March 20	8 0 0	May 24	7 0 0	July 20	7 5 0	October 16	9 0 0
January 18	8 15 0	March 23	7 15 0	May 28	7 2 6	July 31	7 7 6	October 17	9 10 0
January 20	9 0 0	April 9	7 15 0	June 4	7 5 0	August 2	7 12 6	October 19	9 1 0
February 14	8 15 0	April 18	7 10 0	June 6	7 10 0	August 10	7 15 0	October 26	8 17 6
February 14	8 12 6	April 18	7 5 0	June 7	7 15 0	August 27	8 0 0	November 16	8 5 0
February 17	8 0 0	April 19	7 0 0	June 11	8 0 0	September 4	8 5 0	November 30	8 10 0
February 21	8 10 0	April 20	7 5 0	June 18	7 12 6	September 5	8 10 0	December 10	8 7 6
February 21	8 7 6	May 8	6 17 6	July 16	7 10 0	September 13	9 0 0	December 19	8 0 0

LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

1889.

DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.
January 1	9 10 0	February 6	8 0 0	March 11	7 15 0	May 14	8 4 0	July 30	9 15 0
January 2	8 10 0	February 6	7 15 0	March 11	7 12 0	June 6	8 7 6	September 18	9 3 0
January 2	8 14 0	February 8	8 10 0	March 20	7 7 6	June 6	8 15 0	October 1	9 0 0
January 4	8 15 0	February 8	8 2 6	March 21	7 10 0	June 6	8 12 6	October 5	9 0 0
January 9	8 7 6	February 8	8 0 0	March 25	7 8 0	June 12	9 0 0	October 7	9 5 0
January 9	8 10 0	February 15	7 15 0	March 25	7 10 0	June 15	8 16 0	October 30	8 18 6
January 23	8 4 0	March 4	7 12 6	April 1	7 12 6	June 19	9 5 0	October 30	8 19 0
January 23	8 5 0	March 6	7 10 0	April 4	7 12 6	July 7	8 17 6	December 2	9 10 0
February 5	8 0 0	March 6	7 10 0	April 4	7 15 0	July 9	8 15 0	December 2	9 7 6
February 5	7 17 6	March 6	7 6 6	April 10	8 0 0	July 18	9 0 0	December 11	9 15 0
February 5	7 12 6	March 9	9 7 0	May 9	8 5 0	July 23	9 5 0	December 16	9 10 0
February 6	7 10 0	March 11	7 10 0	May 9	8 10 0	July 23	9 10 0		

ENGLISH SHIPMENTS OF QUICKSILVER TO THE UNITED STATES.

The following table shows the shipments of quicksilver from Great Britain to the United States for the years 1880 to 1889, inclusive, by months:

SHIPMENTS OF QUICKSILVER FROM GREAT BRITAIN TO THE UNITED STATES.

[Flasks.]

MONTHS.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	200	4,659	13,116	14,382	4,871	5,112	12,311	10,554	4,649	7,967
January	.....	.....	150	2,207	200	150	300	1,050	100	629
February	.....	178	354	1,753	200	350	156	300	600	500
March	.....	200	981	2,006	600	300	1,012	100	.....	650
April	.....	200	984	2,449	196	500	1,338	2,328	300	851
May	.....	850	540	2,067	500	100	1,778	650	1,899	1,500
June	100	650	1,772	2,500	1,254	500	700	2,000	400	503
July	.....	301	786	.....	21	.....	1,114	1,800	450	481
August	.....	300	1,714	300	450	500	999	910	150	450
September	.....	106	763	400	500	1,854	2,607	350	.....	100
October	.....	220	1,462	200	450	200	701	420	.....	1,550
November	.....	978	2,074	300	300	.....	805	646	.....	103
December	100	676	1,536	200	200	658	801	.....	750	650

THE NEW ALMADEN QUICKSILVER MINES.

The characteristics of the quicksilver mining industry in the United States can best be understood by the following study of the New Almaden mines:

LOCATION.

The quicksilver deposits exploited by the Quicksilver Mining Company are situated in Santa Clara county, California, in a low range of hills, which has a general northwest and southeast direction, and culminates in Mine Hill at the elevation of 1,755 feet above sea level. This range of hills lies parallel and in front of the main coast range of mountains, separated from it by Capitancillos creek and its affluent in the western and by a branch of Alamitos creek in their eastern position. A low transverse ridge, or so-called "divide", separates Alamitos from Capitancillos creek, and connects the Mine Hill ridge with the main coast range. The highest point of the coast range is Mount Bache, situated about 5 miles south of Mine Hill, with an elevation of 3,790 feet above sea level. Mount Umunhum, 3,430 feet high, in the same range, is about southwest of Mine Hill and 3 miles distant, and Mount Chisnantuck, about 3 miles southeast of Mine Hill, is about 1,790 feet high, being the highest point in the range of hills which extends almost northerly from Mount Bache, and is separated from Mine Hill ridge by Alamitos creek with its source on the northern slope of Mount Bache. The city hall at San José is nearly 12 miles distant in a straight line from summit of Mine Hill, in the direction of north 18° west. The northerly slopes of the Mine Hill range descend gradually into the valley of Santa Clara, of which they form the southern rim. The hills are mostly covered with brush and several species of oak on the northern slope, while the southern slopes are more open. The soil is ill-adapted for cultivation, as it forms only a thin layer on the surface. Water is scarce, the Alamitos and Capitancillos creeks dwindling down in summer time to meager streams that disappear entirely at their entrance in the valley, while during the rainy season they form torrential streams. The railroad station Almaden is 438 feet above sea level, according to the railroad surveys, and the office at the hacienda about 500 feet. The climate is moderate both in winter and summer.

PLAN OF THE FURNACE YARD OF THE NEW ALMADEN QUICKSILVER MINE

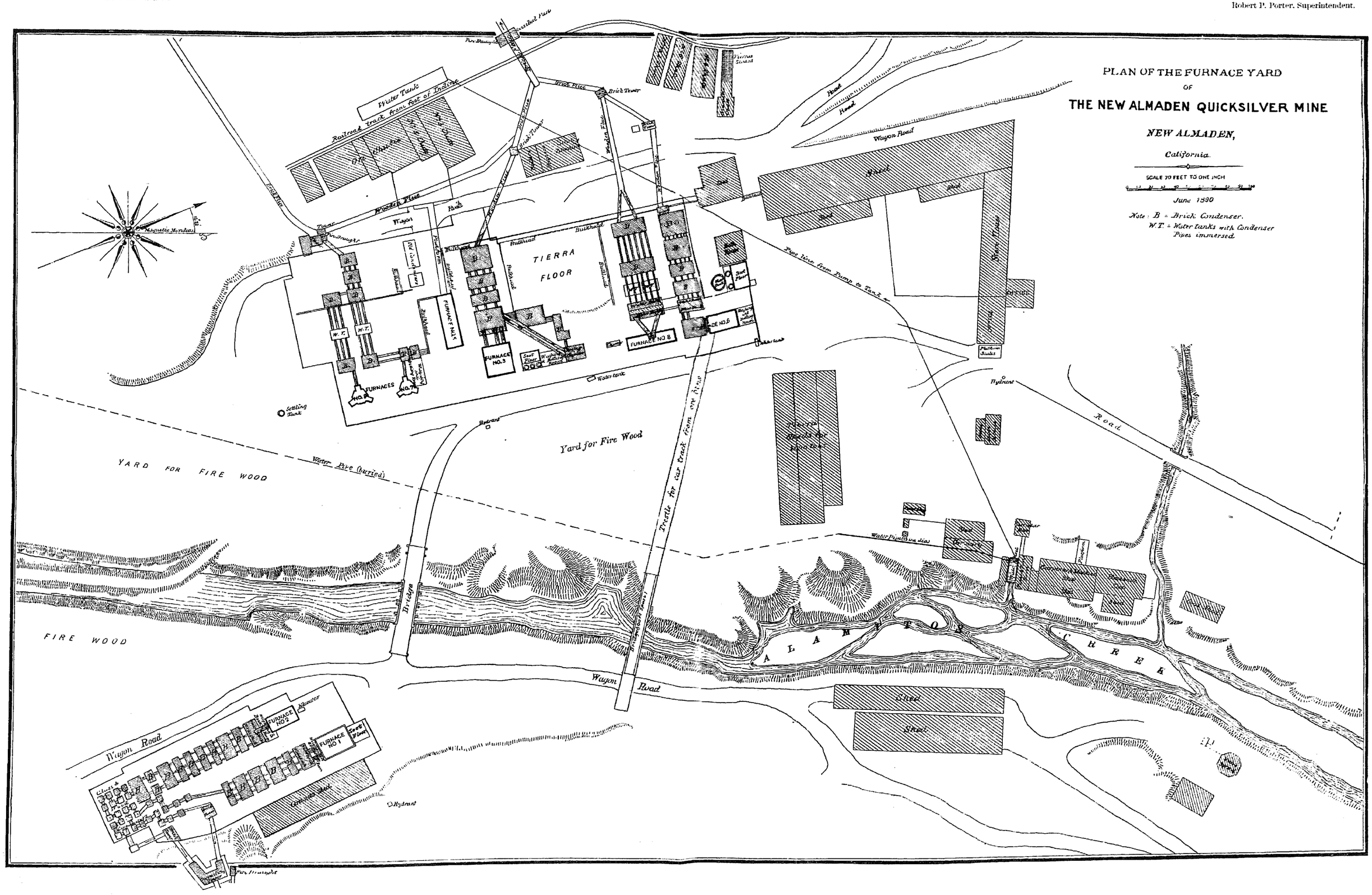
NEW ALMADEN,

California.

SCALE 70 FEET TO ONE INCH

June 1890

Note: B = Brick Condenser.
W.T. = Water tanks with Condenser Pipes immersed.



GEOLOGY. (a)

The New Almaden, Enriquita, and Guadalupe mines lie nearly south of San José, on spurs of the Santa Cruz mountains. This district has been much more productive in quicksilver than any other in North America, and since 1850 it has yielded four-fifths as much metal as the Almaden mine of Spain. Of special interest in the general geology of the district is the occurrence of a rhyolite dike nearly parallel to the line connecting the New Almaden and the Guadalupe. This is the only known mass of rhyolite in the coast ranges.

The greater part of the surface is occupied by metamorphic rocks, which have been determined as neocomian. They are, for the most part, identical with those so prevalent in the coast ranges. There are also masses of limestone. The general structure of the ridges of the metamorphic rock seems to be synclinal. The underlying rock of the region of New Almaden is undoubtedly granite, although it is at considerable depth.

Pebbles of olivine gabbro are found at various points in the district, but this rock has not been found in place. Upon the metamorphic rocks lie uncomformably areas of miocene sandstones. These are soft, yellowish strata, which were sharply folded by a postmiocene upheaval.

Of special importance in relation to the ore deposits is the rhyolite dike. It not only proves the former existence of volcanic activity, but emphasizes a fundamental structural axis. Parallel to this axis are the directions along which compression and upheaval took place in the early cretaceous, and folding of the tertiary rocks occurred at the close of the miocene. The age of the dike is certainly postmiocene, and probably postpliocene. The fissure system of the mines conforms in general direction with that of the dike, and it is probable that their formation is contemporaneous; also, that ore deposition took place at no great interval after the eruption of rhyolite.

MINE MINERALS AND ROCKS.

The ore is cinnabar, sometimes accompanied by native mercury. The associated minerals are pyrite, marcasite, and chalcopyrite. The gangue minerals are dolomite, calcite, quartz, and bituminous matter, the first being more prevalent here than in most quicksilver districts—a fact probably not unconnected with the unusual quantity of limestone in the sedimentary rocks. A small amount of chalcedony and opal, usually black in color, accompanies the deposits. The rocks associated with cinnabar in this district include every variety of the metamorphic series. Where the rock happens to be a permeable sandstone impregnations have resulted. Elsewhere the ore seems to occur exclusively in crevices in the rock, many of which are only partially filled. In some cases quartz, reddened throughout by cinnabar, occurs in this manner. There is no indication that ore has been deposited by substitution, or that the rock has influenced the deposition of ore by its chemical properties. Ore is found with nearly equal frequency in contact with various rocks, and the existence of fissures appears to have been the necessary and sufficient condition for the deposition of cinnabar and gangue minerals. Where disturbances of the country resulted in the formation of open fissures, or of ground presenting a large amount of interstitial space, ore bodies were formed; but where the rock yielded to a stress as a plastic mass no room was left for ore.

ORE DEPOSITS.

The commonest type of the ore deposits is the reticulated mass or stock work, consisting of irregular bodies of broken rock into which solutions of cinnabar and gangue minerals have filtered, cementing the fragments together with ore; clean cut fissures filled with ore may be seen, and these can only be classed as veins, though they are not persistent.

The ore in the New Almaden mine seems never to occur except close to evidences of faulting. This evidence consists in the presence of layers of attrition products, so-called clays, full of slickensides, and of fragments of rocks more or less rounded by attrition. These layers of clay usually occur on the hanging side of deposits, and are known to the miners as "altas", the Spanish term for "hanging walls". The clays are impermeable to solutions and the ore usually forms on their lower side, as if the cinnabar had ascended and had been arrested by the altas. That the solutions really took this course is clearly shown by the phenomena of other quicksilver districts as well as by the relations observed in the New Almaden mine. The miners very properly follow seams of alta in their search for ore. Sometimes, however, a second mass of ore exists on the hanging side of the clay, and is again limited by a second layer of alta. Such occurrences are to be expected in a country so irregularly disturbed as this. The alta is not a definite substance, though it is usually a dark or black mass readily distinguished even in hand specimens from the country rock. It is simply triturated country rock, and varies in composition with the material from which it has been produced. Its black color is in part due to the presence of manganese. The evidence of moving in the New Almaden mine is not confined to clays. Where the opposing walls were so nearly parallel that no considerable quantity of trituration took place, polishing occurred, and some of the slickensides met with are as brilliantly polished as if the work had been done by a lapidary.

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a This article and the following under the headings of "Mine minerals and rocks", "Ore deposits", and "Fissure system" are short abstracts of the article, "Descriptive geology of the New Almaden district", in Mr. George F. Becker's monograph on the geology of the quicksilver deposits of the Pacific slope.

FISSURE SYSTEM.

The various ore bodies of the mines are arranged in subordination to a general fissure which stands in close relation to the general geology of the district. The fissures are the result of a widespread disturbance, and the direction of their strike, southeast and southwest, coincides with the direction of the fundamental axis of the disturbance. The workings in the main portion of the New Almaden mine have developed two principal fissures, dipping north. One of these dips from the surface at a high angle, and in a nearly straight line. The other strikes in nearly the same direction as the first, dips steeply from the surface, then flattens and approaches the first fissure rapidly, and in the lower workings almost coincides with the first. The first fissure contains the ore bodies east of the Randol shaft, which are continuous from the 800-foot to the 1,900-foot level; also the ore bodies west of the shaft in the hanging wall side of the other fissure, which have been worked from the 1,400-foot to the 2,000-foot level. The second fissure contains the continuous ore chute, which extends from the summit of Mine Hill toward the Santa Isabel shaft down to the 2,000-foot level.

The ore deposits of the Cora Blanca and Washington shafts have no connection with those of the main mine. In the former ore has been traced to a depth of 750 feet below the summit of Mine Hill, and in the latter to a depth of 850 feet. The Cora Blanca deposit has a strike of north 18° west, magnetic, and has a dip of 40° to the east. The strike of the Washington deposit is about north 55° west.

The ore-bearing ground of the Enriquita mine was about 500 feet in length, and had an extreme width of about 60 feet, the dip being nearly vertical. The ore was found in rich pockets in limestone, which was inclosed on both sides by serpentine.

Besides the mines mentioned, there are a number of abandoned ones, none of which was ever very productive or very extensively developed.

All the deposits of the district appear to occur along a rather simple fissure system. The main fissure is nearly parallel to the rhyolite dike at the Guadalupe mine. It follows the direction of the hills, the axis of which curves gradually away from the dike for a certain distance. Passing through or near the San Antonio and Enriquita, it seems to break across the ridge at the America and enters the Almaden on the strike of its great fissure. The Washington seems to be on a branch of the main fissure.

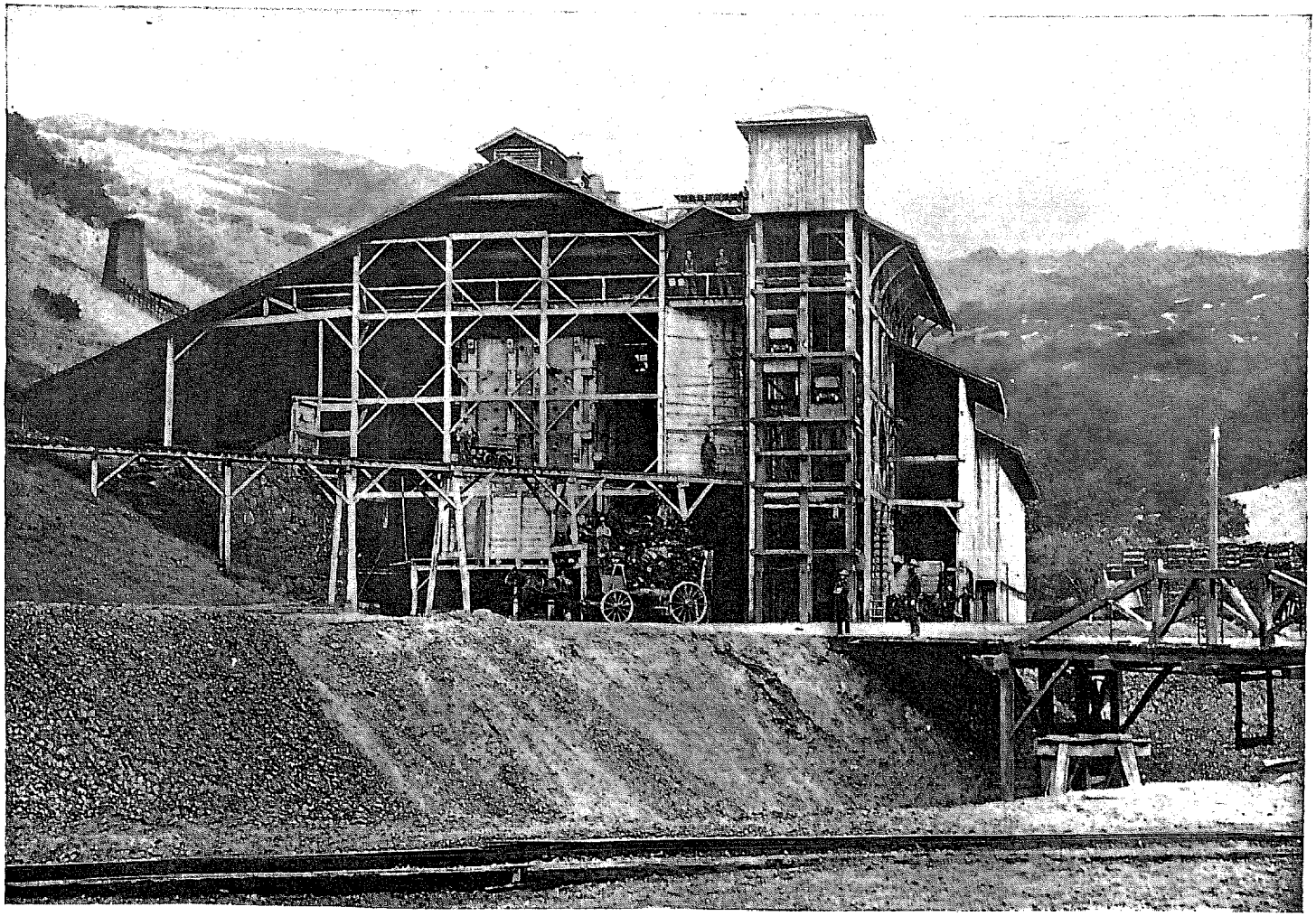
HISTORY OF THE MINES AND REDUCTION WORKS.

Andres Castillero, a Mexican captain of cavalry, was sent by his government in October, 1845, to California to confer with General Sutter for the purchase of his fort, established in what is now Sacramento county. Having arrived at Monterey, he began his land journey about the middle of October, 1845. Being informed that a valuable mine existed in the hills some leagues south of Santa Clara, he went there to inspect the mine, which was then known as Chaboya's mine(*a*). Castillero, having some knowledge of assaying, tested the mineral, which he thought contained some gold and silver and a very small percentage of quicksilver. This last metal he considered then of little importance. On November 22, 1845, he made the "denouncement" of the mine before the alcalde of Santa Clara, naming the mine Santa Clara, in which he claimed to have discovered a vein of silver with an alloy of gold, being situated on the rancho pertaining to José Reyes Bereyessa.

On December 3, 1845, he again appeared before the same alcalde and stated that on opening the mine which he had previously denounced in his court he had, besides silver with an alloy of gold, also taken out liquid quicksilver, and on December 30, 1845, Antonio Maria Pico, the alcalde, gave Castillero judicial possession of the mine, to be known as Santa Clara.

Castillero associated with him in this enterprise Don José Castro, then commanding general of the Mexican forces at Monterey, Secundino and Teodoro Robles, and the father friar José Maria del Refugio Suarez del Real, and went with the last named to the mine to begin operations in December, 1845. Castillero and Padre Real employed William G. Chard, a native of New York, to open the mine. Having no retorts of any kind, Chard put the ore in gun barrels, the mouths of which he placed in water, and, heating the barrels over a fire, distilled some metal. This process, however, was soon abandoned for a better one. A hole or well was dug in the ground and a trough full of water was placed in the bottom. Bars of iron were laid across the top of the well, and a copper still with the upper part coming up through the bars reached down into the water. Ore was then piled on the bars, and a whaler's trying pot was reversed over the heaped ore, wood piled around the pot and over it, and then set on fire. The mercury vapors were forced through the pipe into the water by the heat. In this primitive way from 3 to 4 tons of ore could be reduced with from 6 to 8 cords of wood, the operation lasting from 16 to 18 hours. As the escaping vapors made the work very dangerous, Padre Real conceived the idea of building a new furnace. This was made of adobes, 10 feet high and about 8 feet in diameter on the outside, with 2 chambers inside, one above the other. The top of the lower chamber, which was used as the fireplace, was made full of holes, through which the flames could pass into

a It is also stated that the mine had been known long before this time, and that Antonio Suñol, Luis Chaboya, and an old man named Robles first discovered and worked the mine as early as 1824, and that to work the ore a mill had been built by Chaboya on the creek now called Alamitos. It is also said that the Indians came to the mine to get paint, which they called "pooyi".



QUICKSILVER FURNACES Nos. 1 AND 2, 1889, NEW ALMADEN, CALIFORNIA.

the upper chamber that was filled with ore. The upper chamber had a large hole on top for charging it with ore. This hole was closed by an iron door during the operation of firing, and cemented, and 6 or 8 iron pipes led the vapors from the upper chamber into a water tank (evidently a copy of the Bustamente furnace without the aludels). This furnace, built only of sun-dried bricks, or adobes, did not succeed very well, as it bursted when the fire became very hot, and badly salivated Chard and the men working at it. It was therefore charged only once.

Castillero had returned to Mexico early in 1846 to report the result of his mission, and while there appealed to the Mexican government for aid in his mining enterprise, in which he succeeded. A contract was made with him in the City of Mexico in May, 1846, by which the government agreed to advance to Castillero and his associates the sum of $5,000 and give other aid for the development of the mine. Unluckily for Castillero, the difficulties just then broke out between the United States and the Mexican government, which ended in the cession of California, and the Mexican government, foreseeing this danger, stopped the payment of the stipulated sum to Castillero. Padre Real had been left at the mine to take care of it. Left to their own resources, and not having the means to carry on the work and make the necessary improvements, Don José Castro, for himself and associates, then made a contract with the banking firm of Barron, Forbes & Co., of San Blas and Tepic, Mexico, by which the latter became lessees of the mine for 16 years, and some time after making the contract became part owners in the mine by the purchase of some of the shares. Mr. J. A. Forbes took charge of the mine for Barron, Forbes & Co. in August, 1846, possession being given by Padre Real. The new firm changed the name of the mine, calling it New Almaden.

When Forbes arrived at the mine the underground workings consisted only of an adit or horizontal entrance 20 or 25 feet in length through the rock. The quicksilver ore was in sight on either side. There was a floor or planilla on the outside of the tunnel, formed of the waste material broken from the mine. Chard, as major-domo, was in charge, assisted by a white man (a blacksmith) and several Indians. One of the Indians remained constantly at the mine to guard it, and slept in the tunnel at night. They were then not actively engaged in extracting ore, but the reduction of the ore took place at the hacienda near the creek every day, sometimes with 2 pots. The ore was brought down from the hill on mules' backs. A log house, as dwelling, and a blacksmith shop were the only buildings constructed. Forbes received from Padre Real 2,000 pounds of quicksilver that had already been distilled. (*a*)

Forbes then erected furnaces with retorts made of 4 potash kettles, built into walls of adobe, with condensers of masonry work immediately adjacent. 400 pounds of ore of average quality, broken into lumps the size of an apple, were put into each kettle or retort, the covers put on and luted with a layer of sand. The fires were then kept up till near night, when the furnaces were allowed to cool gradually. On the next morning the condensers were opened and the metal, which usually amounted to from 300 to 400 pounds from the 4 pots, dipped up. This was a much less percentage than the usual assay indicated, and it was obvious that a large portion of the metal was lost. Forbes wished to devise some way of extracting the metal without mixing lime with the ore in roasting, but was unsuccessful. At length a kiln of lime was burned, and "I am informed", says Rev. Chester S. Lyman, the surveyor, "that the ores yield with this a vastly greater percentage of metal. In the last 3 weeks about 10,000 pounds of metal have been extracted with the same apparatus, being a yield of over 50 per cent". Mr. Lyman stated that in February, 1848, while Alexander Forbes was at the mine as superintendent, there were 4 furnaces in operation for extracting quicksilver, employing from 20 to 30 men. (*b*)

Dr. Tobin arrived from England during the year 1849 to take charge of the reduction works. According to his letter in Ure's Dictionary of Arts, volume II, page 140, the mine resembled then a gigantic rabbit warren. Its greatest depth was about 150 feet, and the weekly extraction of ore varied from 100 to 150 tons. Dr. Tobin got 16 cylinders (retorts) at work, producing from 1,400 to 1,500 pounds of quicksilver daily. This result was satisfactory so far as production was concerned, but not so as regarded expense in fuel and labor. 6 furnaces of the Idria style were built by Mr. Baker, each of 1 ton capacity, and 2 more of a larger size by Dr. Tobin. Very rich ore was burned in these furnaces, but as they were badly constructed so far as the bottoms of the condensers were concerned, very large quantities of quicksilver ran through the foundations into the ground, which in later years was recovered by washings. The small Baker furnaces were built on the south side of Alamitos creek, and Tobin's furnaces on the north side. Tobin's big furnace did not last long; it burst in many places, and salivated all the workmen. It was therefore determined to build the so-called medium furnaces of about 15,000 pounds capacity.

Mr. Russell Bartlett, the United States commissioner on the Mexican and United States boundary question, who visited California in 1853, states that the quantity of quicksilver annually produced at New Almaden exceeded 1,000,000 pounds, and makes mention of 6 furnaces that were kept going night and day. 7 or 8 days were required for 1 furnace operation; that is, charging, firing, and discharging. The men working at the furnaces were so much affected by the escaping vapors that they were kept at the work for 3 or 4 weeks only, when a fresh set of workmen were put in their place.

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a Silliman's Journal: Letter of Rev. C. S. Lyman, Pueblo de San José, March 24, 1848.
b United States *vs.* Andres Castillero, No. 420, 1859, page 12, transcript of record.

Mr. Ruschenberger gives a more detailed account of the distilling apparatus, as follows: (*a*)

A kind of reverberatory furnace 3 feet by 5 feet is arranged at the extremity of a series of chambers of nearly, if not exactly, the same dimensions, namely, 7 feet long, 4 feet wide, and 5 feet high. There are 8 or 10 of these chambers in each series, built of brick, plastered inside, and secured by iron rods, armed at the ends with screws and nuts as a protection against the expansion by heat. The tops are of boiler iron, luted with ashes and salt. The first chamber is for a wood fire, the second is the ore chamber, which is separated from the first by a network partition of brick. The flame of the fire passes through the square holes of this partition, and plays upon the ore in the ore chamber, which when fully charged contains 10,000 pounds (5 tons) of cinnabar. Next to the ore chamber is the first condensing chamber, which communicates with it by a square hole at the left lower corner. An opening at the right upper corner of the partition between the second and third condensing chambers communicates with the latter. The openings between the chambers are at the top and to the right and at the bottom and to the left alternately, so that the vapors from the ore chambers are forced to describe a spiral in their passage through the 8 condensers. The vapor and smoke pass from the last condensing chamber through a square wooden box, 8 or 10 feet long, in which there is a continuous shower of cold water, and finally escape into the open air by tall wooden flues. The floor or bottom of each condensing chamber is about 2 feet above the ground, and is arranged with gutters for collecting the condensed mercury and conveying it into an open conduit, along which it flows into an iron receptacle, from which it is poured into the iron flasks. There are 14 of these furnaces and ranges of condensers, with passages of 8 or 10 feet in width between them. A shed is constructed above the whole at a sufficient elevation to permit free circulation of the air.

The firing was kept up for 60 hours, and the furnaces required 48 hours for cooling before they could be discharged. The fine ores were mixed with clay and water and made into bricks called "adobes", size 10 inches by 4.5 by 4.5 inches, dried in the sun. The larger pieces of ore and adobe were then piled up in the ore chamber, which, when fully charged, contained about 5 tons of ore. This style of furnace remained in operation during the following years, the only modifications made being the size, which was considerably increased.

In 1863, when the Quicksilver Mining Company took possession of the property, there were 5 intermittent furnaces at the hacienda, while a new furnace, No. 6, was completed in December, 1864, with a capacity of 84 tons.

NUMBER OF FURNACE.	When first put in operation.	Capacity. (Short tons.)
1	July, 1861	40
2	May, 1862	40
3	November, 1862	40
4	September, 1863	40
5	May, 1864	40

Furnace No. 1 was the only one built without iron plates in its foundation, while all the other furnaces were so provided.

The subsequent improvements in the furnace plant were as follows:

In 1873 the first shaft furnace continuous in operation was built, after the Page patent, on the site of old furnace No. 2, which was removed for this purpose.

Furnace No. 5 (*b*) received an addition to its condensation plant by the erection of 2 iron condensers of the Fiedler patent.

Furnace No. 6 (*b*) had a wooden condenser added, 26 feet in length, 14 feet in width, and 20 feet high, containing 6 chambers of equal size. The result of this addition was very gratifying, as was found by the examination of the flue, which formerly had yielded from 60 to 100 flasks of quicksilver annually and only 2 flasks after the new condensers went into operation. The flue was also extended a distance of 100 feet and a new smokestack erected.

Furnace No. 7 (*b*), having been unserviceable for 3 years was torn down, with its first 3 condensers.

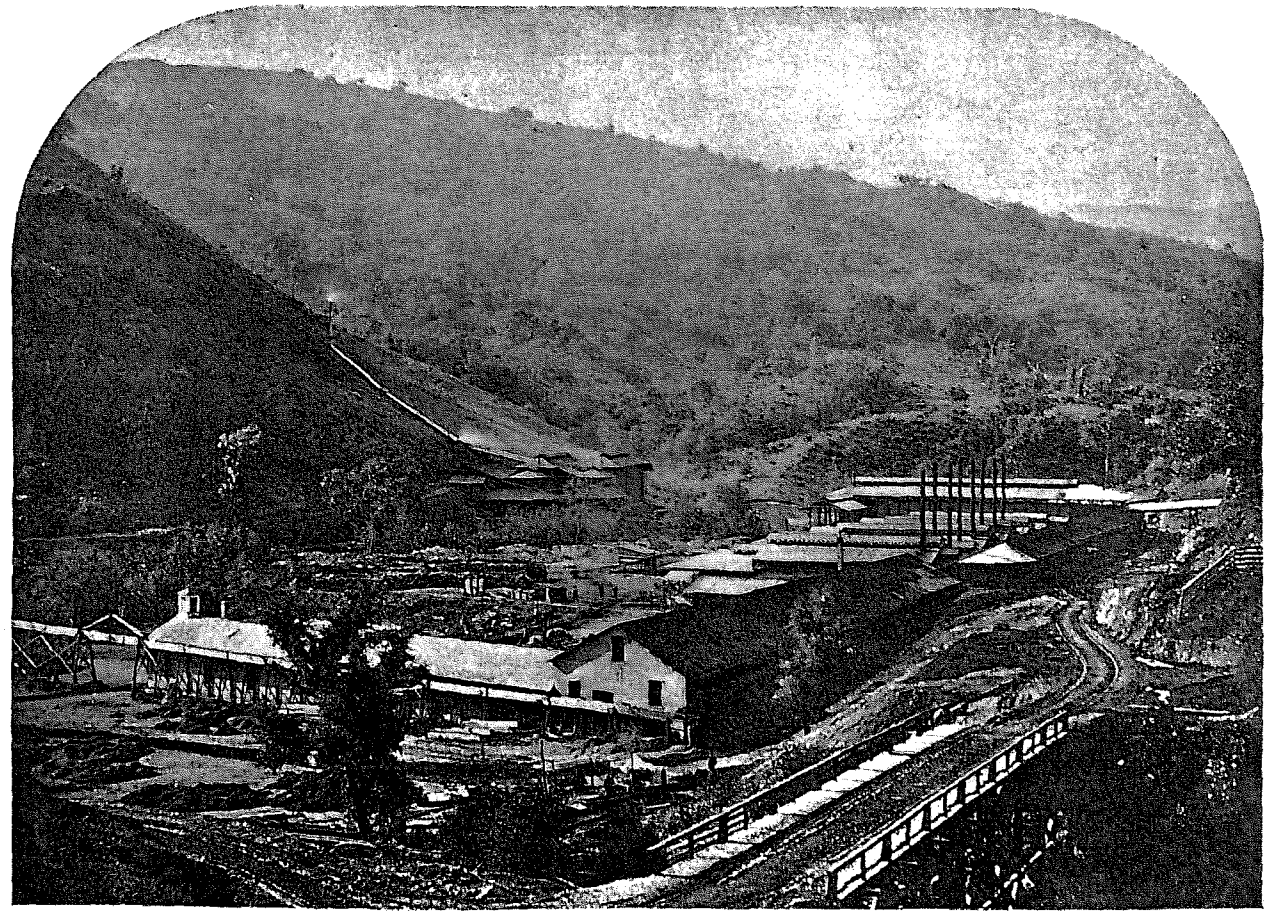
Furnace No. 1 had then 17 condensing chambers; No. 2 18 condensing chambers; Nos. 3 and 4 combined 39 condensing chambers; No. 5 20 condensing chambers, besides 2 Fiedler condensers, and No. 6 20 brick condensing chambers and 6 wooden chambers.

Another improvement with advantageous results was the introduction of openings (covered with glass) into all the upper part of the brick and wooden condensers, allowing the outer and cooler air to come more easily in contact with the hot fumes, as the thickness of a thin pane of glass only intervened, which insured a more rapid and thorough condensation. Trials were also made during 1873 to introduce the combustible with the ore. Coal, coke, and charcoal were first used, but later only coke and charcoal, as the use of coal was not considered beneficial. It was considered that this process would be advantageous in burning and roasting the ore more perfectly and rapidly, especially in places where the flame from the wood fire of the fireplace could not reach freely.

In 1874 the continuous shaft furnace No. 2, built in the previous year according to the Page patent, not proving as beneficial as anticipated, the discharge of ore being irregular, was partially razed and rebuilt into an improved, old style intermittent furnace, and exclusively used for the burning of adobes, with a capacity of 111,000 pounds of adobes per charge, or 444,000 pounds per month. The condensing chambers of this furnace, which were the same as originally used for the old furnace, consisting of a solid block of 18 chambers, were divided into 2 blocks by cutting out one of the chambers and thereby obtaining a better circulation of air, not only on the outside walls but also through the lower arches and passageways on which these condensers are built. The subject of a more economical and improved method of reduction and condensation was the object of constant study and experiment,

a Ure's Dictionary of Art, supplement, page 743.

b Built prior to 1870, and intermittent.



NEW ALMADEN—THE REDUCTION WORKS, OR "HACIENDA", IN 1870.

and the results are evidenced by the introduction of the new iron condensers of the Fiedler patent and those made of wood and glass of the Randol & Fiedler patent, also the introduction of the improved method of extracting quicksilver from the soot by the Randol & Wright process. 4 wood and glass condensers of the new style were built for furnace No. 5, each being 22 feet long, 8 feet wide, and 15 feet high, a cast-iron condenser of the Fiedler type being also added. A wooden tower, with an upcast and downcast shaft, was erected for furnaces Nos. 1 and 2, in the rear of the last condenser, the downcast shaft being supplied from the top with a spray of water which fell through a series of triangular wooden cross-pieces inserted into the sides of the shaft in alternate opposite directions, which divided the water into minute particles, intended to combine with the fumes from the condensers, in order to precipitate all the metallic content reaching this point.

Furnace No. 7, ironclad, of the continuous type, nearly alike to those in operation at the Idria mine in Austria, was also commenced in 1874 and finished in 1875. 2 brick towers and 2 large brick condensers were added to the plant of this furnace. From these the fumes were made to pass through the condensers of furnace No. 5 (not then in operation), and thence into the 4 new wood and glass condensers above mentioned. As this left furnace No. 5 with only 2 iron condensers, a new series of condensers were built for the latter furnace, of which 2 were of brick and 3 of wood and glass, the last ones being each 12 feet long, 12 feet wide, and 20 feet high, with 34 large windows, each condenser being divided into 4 chambers. A new flume 1,000 feet in length, made of Oregon pine and leading to a central chimney, was also built, which received all the fumes from furnaces Nos. 3, 4, and 6. The old brick condensers were provided with new openings, closed in by windows of glass or iron, for better cooling the vapors.

In 1875 the flue began in 1874 was completed and proved of much benefit by carrying the smoke away from the hacienda. Another wood and glass condenser, 12 feet square and 20 feet high, made into 4 compartments and provided with 34 large windows, was added to the plant of furnace No. 5. Furnace No. 7 received the addition of 2 brick towers to its condensation plant, each 7.5 feet wide, 12 feet long, and 26 feet high; also 2 brick condensers, one 27 feet long, 10.5 feet wide, and 27 feet high, and the other 20 feet long, 20 feet wide, and 10 feet high. Furnace No. 1 received the addition of another large wooden condenser built on the same plan as those for furnace No. 5. The wooden tower erected in 1874 for furnaces Nos. 1 and 2 and provided with water spray was removed, as it was found to operate badly. To give additional condensing space to furnaces Nos. 1 and 2 a large brick tower was erected on the adjacent hillside and connected by wooden flues with the last condensers of these furnaces, whence the smoke passes into the main flue that leads up the mountain side to the chimney. The brick chimney serving as outlet to furnaces Nos. 5 and 7 was raised a further height of 32 feet, altogether 62 feet, to increase its draft. 2 Fiedler iron condensers were added to the condensing plant of furnace No. 6 and connected with a Root blower, driven by a small steam engine, to withdraw from the furnace any mercurial vapors remaining after firing had ceased (the furnace being intermittent). Foundation was laid at the end of December, 1875, for another ironclad furnace, No. 9, similar to No. 7 (*a*), in successful operation. Experiments were made with the object of constructing a continuous furnace for the burning of tierras without making them into adobes, and No. 5 furnace was changed into a trial furnace for this purpose, and worked so satisfactorily that plans were made for the double continuous furnace, No. 8 (*b*). The construction of the additional condensers, wherever found necessary, during the past 2 years had given very good results, and scarcely any quicksilver was found in the flues leading away from the last condensers, and in the whole aggregate length of these flues of 1,643 feet (leaving out joint flue of Nos. 5 and 7 furnaces, as both furnaces were in operation and are continuous in action) only 6 flasks of quicksilver were collected after a run of 16 months' operation.

The 2 ironclad continuous furnaces, No. 9, for granza or coarse ore, and No. 8, for tierras or fine ore, were completed and put in operation during the year 1876. It is interesting to show the cost and profit of working the continuous tierras furnace, based on actual work for 39 days and giving 1.40 per cent yield of quicksilver:

Cost of tierras at the mine and dumps, 10 cents per carga, or per ton	$0.67
Cost of transportation	0.35
Total cost of tierras	1.02
One day's supply for No. 8 furnace, 24 tons, at $1.02 per ton	$24.48
Labor of 5 men in 24 hours	12.00
Fuel, 2.57 cords wood, at $6 per cord	15.42
Flasks	9.00
Total cost, $7.766 per flask, or	60.90
Estimated daily yield, 9 flasks of quicksilver, at 50 cents per pound	344.25
Daily profit	283.35

As the furnace is expected to run at least 300 days in the year, the annual profit would be $85,000 from this furnace alone. The dumps and old workings of the mine contained a large amount of tierras that could be profitably worked in this new furnace. Of the old style intermittent furnaces No. 6 was the most favorable exponent, giving the best results for labor and fuel. In 1876 the average cost of working ores in it was $1.97 per ton, of which 63

a Continuous furnace of Exeli type.

b Tierra furnace, Huttner & Scott patent.

cents was for furnace labor and $1.34 for fuel. To roast tierras in the intermittent furnaces it was necessary to first make them into adobes, at a cost of 95 cents per ton for making and handling.

With this data the cost of roasting all the ores handled in 1876 can be arrived at if the work had been done in the old style furnace under the most favorable circumstances:

The coarse ores roasted were 7,392 tons, at $1.97 per ton	$14,562.24
9,266 tons tierras cost $1.97 per ton roasting and 95 cents per ton making into adobes and handling, together $2.92 per ton	27,056.72
Total cost of 16,658 tons for labor and fuel, $2.4985 per ton	41,618.96

Now, the ironclad continuous furnaces Nos. 7 and 9 roasted coarse ore at a cost of $1.1833 per ton, of which there is for furnace labor 52 cents and fuel 66.33 cents; the continuous tierras furnace No. 8 works tierras without making into adobes at a cost of $1.1425 per ton, 50 cents being for labor and 64.25 cents for fuel. The cost would therefore be as follows:

7,392 tons coarse ore roasted in improved furnaces (continuous), at $1.1833 per ton	$8,747.20
9,266 tons tierras not made into adobes but roasted in new continuous furnace, at $1.1425 per ton	10,586.40
Total cost of 16,658 tons for labor and fuel, at $1.1606 per ton	19,333.60
The year's work in old furnaces cost	41,618.96
The year's work in new furnaces cost	19,333.60
In favor of new furnaces, 53.54 per cent	22,285.36
Cost per ton, old furnaces	2.4985
Cost per ton, new furnaces	1.1606
Decrease, 53.54 per cent	1.3379

The first 3 condensing chambers of No. 6 furnace were taken down and in their place a new condenser with drying chamber for moist tierras was erected. The first block of condensers of furnace No. 5 was covered on top with iron plates to form a drying floor for moist tierras. The ironclad furnace No. 9 was completed in April, and was started on May 13. 2 brick condensers and 2 wood and glass condensers were erected for this furnace and connected with the four similar condensers formerly belonging to No. 5.

For a period of 4 months continuous operation of the 2 ironclad shaft furnaces, Nos. 7 and 9, it was found that the amount of ore burned was:

	POUNDS.
Granza	3,113,600
Terrero	1,571,200
Total	4,684,800

or 2,342.4 tons.

The expenses were:

For labor	$1,220.00
For 182.75 cords of wood, at $6 per cord	1,096.50
For 70,272 pounds of coke, at $13 per ton	456.76
Total	2,773.26

The furnaces during this time yielded 6,382 flasks of quicksilver, with the following result:

Cost of labor per flask	$0.190
Cost of wood	0.172
Cost of coke	0.072
Total cost per flask	0.434

The new ironclad tierras, furnace No. 8, Huttner & Scott patent, was completed in October and started November 1, 1876. This furnace roasts 24 tons of tierras in 24 hours. It has two brick condensers covered and joined by iron plates, which serve as a drying floor for tierras, 2 iron condensers, and 7 condensers of wood and glass. The furnace itself is 46 feet high, 10 feet wide, and 38 feet long.

In 1877 a large bathhouse was built for the men working at furnaces. A new brick flue was built for furnaces Nos. 3, 4, 6, and 8, and a brick chimney was added 81 feet high. The cornerstone was laid on August 25, 1877, for a new granzita and tierras furnace, No. 3, of the Huttner & Scott type, on the site of old intermittent furnace No. 3, which was torn down.

Comparing the results from No. 8 furnace with assays of samples taken from each car of tierras before charging the furnace, it was found that during the months of November and December, 1876, and January, February, March, and April, 1877, this furnace roasted 5,278,000 pounds of tierras, the actual yield of which amounted to 81,319.5 pounds of quicksilver, while the theoretical amount according to assays indicated 87,862.5 pounds contained in the ore. This shows a loss in reduction of 6,543 pounds, or 7.45 per cent. Allowing, however, 5 per cent of the total weight of the tierras for moisture, there was only a loss of 2.58 per cent.

With the coarse ore furnaces, Nos. 7 and 9, from which assay samples could not be obtained without a great deal of trouble and additional expense, a similar calculation could not be made, but as these furnaces had each a separate system of condensers (No. 7 nearly all of brick and No. 9 of brick and the greater part of wood and glass), it was remarkable that after a continuous campaign with these furnaces for 9 months ended May 31, 1877, during which time each furnace roasted 5,241,600 pounds, the ore for both furnaces having been taken from the same ore bin, the yield of No. 7 furnace was found to have been 7,539 flasks, and that of No. 9 furnace 7,541 flasks, the difference in yield between the 2 furnaces being only 2 flasks.

Large weighing scales had been placed on the track over which the loaded cars passed, so that each charge of 1,600 pounds of ore was accurately weighed.

In February, 1878, the new ironclad furnace No. 3 was completed. On December 30 of the same year the work of furnaces Nos. 7 and 9 ended for the purpose of annual cleaning. The result was for No. 7 furnace, 716 flasks, and for No. 9, 720 flasks, a difference of 4 flasks, both furnaces having been charged with equal amounts of the same grade of ore. In furnace No. 7, however, a trial had been made of adding 240 pounds of lime to each charge, but as the furnace produced less quicksilver with the same grade of ore the addition of lime was not considered beneficial and was discontinued.

The intermittent furnace No. 2 was changed into a Huttner & Scott continuous furnace for granzita, with a daily capacity of 18 tons, and received the first charge of ore on June 20, 1879. Furnace No. 1 was pulled down and rebuilt like No. 2 furnace, with a capacity of 36 tons daily, and finished in January, 1880. The condensation plant of both furnaces was also increased at the same time by adding 14 wood and glass condensers of the latest style, each 4.5 feet square and 25 feet high, to furnace No. 2, and 21 of the same style to furnace No. 1.

During the year 1882 one Idria condenser, consisting of three cast-iron pipes, each 22 inches in diameter, standing in a tank and surrounded by cold water, was added to the condensing system of furnace No. 7. The flue leading from furnaces Nos. 7 and 9 having been also connected with the brick flue leading to the chimney for furnaces Nos. 3, 6, and 8 during the previous year, a Guibal fan, worked by a small tangent wheel driven by water under high pressure, was added to the brick flue to exhaust the smoke by strong draft. The large brick condensers of furnaces Nos. 3 and 6, and later on those of Nos. 1 and 2, were improved by cutting out every third chamber and connecting the different blocks by a system of inclined earthenware pipes. The so-called water back, consisting of a number of 4-inch tubes filled with running water and passing through one of the chambers nearest the furnace, was first tried with furnace No. 2, and gave such good results that this system of cooling the vapors was finally introduced in all the first two condensers of the different furnaces.

In the year 1882 experiments were made to burn coal, in part, with wood. These experiments gave good results with some of the furnaces, but were discontinued immediately in furnaces Nos. 7 and 9, as the small amount of coal used (300 pounds, in place of one-fourth of a cord of wood) did not generate the required heat. A set of wooden screens to aid the condensation of the vapors was introduced in one of the rear condensers of furnace No. 2, and the same arrangement added to condensers of furnace No. 3. Two new brick condensers were built in place of the wood and glass condensers for furnace No. 8, each being 10 feet wide, 29 feet long, and 30 feet high, covered on top with iron plates cooled by flowing water, and each divided into 2 chambers, the last condenser also provided with sloping zigzag screens. A water-tank condenser like that for furnace No. 7 was also added, differing only in having earthenware pipes in place of the costly iron ones. The iron roofing, being soon destroyed by the acid vapors, was replaced by thick boards, and the use of water thereon for cooling was abandoned in consequence.

The introduction in the line of condensers in 1881 and 1882 of water backs and the new style of Idria condensers, consisting of cast-iron pipes standing in a tank of cold water, also the partitioning of the larger condenser chambers, proved very effective, as demonstrated by the small amount of quicksilver obtained in the rear condensers and the proportional amount in the first condensers of the system thus fitted up. The artificial draft by the Guibal fan also worked so well that no further cases of salivation occurred. Furnace No. 9 was supplied, therefore, with a new Idria condenser like No. 7, with iron pipes and water tank, and new brick condensers containing revolving screens were added during the year 1883.

In 1885 a Guibal fan was placed in connection with furnaces Nos. 1 and 2, and the chimney flue of these furnaces was extended 270 feet farther uphill in 1887.

A detailed account of the furnaces and condensers has been published in the transactions of the American Institute of Mining Engineers, volumes XIII and XIV, from papers by Samuel B. Christy, Berkeley, California, entitled "Quicksilver reduction at New Almaden", and "Quicksilver condensation at New Almaden". A few changes have been made in the furnace work at New Almaden since the publication of these papers.

The addition of 1.5 per cent of fuel in the form of coke and charcoal to every charge of 1,600 pounds of coarse ore in furnaces Nos. 7 and 9 has been discontinued since the beginning of the year 1888, with the results that the vapors are not overheated, and, being less expansive, travel a less distance before they are condensed. The same addition of fuel to the granzita ore had been discontinued long before.

During the year 1888 an electric plant was installed at the hacienda to drive the Guibal fan for furnaces Nos. 1 and 2, which are on the east side of the creek. This plant proved so satisfactory that it was enlarged by the installment of a 16-horsepower dynamo at the Buena Vista shaft, with motors at each of the 2 Guibal fans, the

connection being made by 7,000 feet of wire. The power is supplied by a small upright engine at Buena Vista shaft, resulting in a saving in fuel and labor and lessening the danger of fire at the furnace yard. Careful measurements have shown that 0.5 horse power is sufficient to drive one of the Guibal fans at a velocity of 60 to 70 revolutions per minute, which is the ordinary speed maintained when condenser cleaning is not being done and all the doors are closed. During condenser cleaning, with usually 1 condenser door open, the speed is increased to 120 revolutions, more or less, depending very much upon the state of the weather.

FURNACE PLANT AT NEW ALMADEN IN 1890.

Number of furnace.	Continuous.	Intermittent.	STYLE.	Daily capacity in tons.	Class of ore roasted.	Number of separate brick condensers.	Total number of brick condensers.	Number of brick towers.	Number of glass and wood-towers.	Number of water-back condensers.	Number of Idria condensers (*a*).	Remarks.
1	1	.....	Huttner & Scott	36	Granzita	6	10	1	21	3	.....	Connect with one chimney.
2	1	.....	do	18		11	16	2	14	2	.....	
3	1	.....	do	36	Tierras	7	20	1	.....	.....	.....	
5	1	.....	do	20		4	10	.....	.....	.....	.....	
6	.....	1	Old	5½	Granza	7	16	2	.....	2	.....	Connect with one chimney (*b*).
8	1	.....	Huttner & Scott	24	Tierras	4	8	.....	.....	2	2	
7	1	.....	Ironclad	10	Granza	6	9	1	.....	2	1	
9	1	.....	Exeli	10		2	*c*5	.....	.....	2	1	

a This condenser consists of iron pipes or earthen pipes cooled in a water tank.

b A connection exists also by separate brick flues to another brick chimney common only to furnaces Nos. 7 and 9.

c The second brick condenser connects with the fourth brick condenser of No. 7, both furnaces mingling their fumes at this point.

The continuous efforts made to improve the working of the soot and to replace the manual labor of stirring it on inclined planes, which was the process in use during the last few years, finally culminated in 1888 in the invention by Superintendent Von Leicht of a soot machine by which the soot is cleaned by steam power.

The apparatus consists of a cast-iron pot of nearly hemispherical shape, 3 feet 5 inches in diameter and 18 inches in depth. A perpendicular shaft passes down through the center of this vessel, the lower end of which is provided with 4 screw blades that fit exactly the inner surface of the vessel and are made only 12 inches high, the upper edge of each blade being horizontal. The shaft to which the blades are attached passes through a circular opening in the bottom of the vessel just large enough for revolving easily in it, with a play of about one-sixteenth of an inch. The vessel being filled with the soot to be cleaned (each charge contains 3 cubic feet), the shaft is made to revolve by proper overhead gearing between 30 to 50 revolutions per minute. In these revolutions the soot is scraped up by the blades and drops over the upper edge onto the next blade, and so on, keeping constantly in motion, and thus bringing the small globules of quicksilver in contact with each other, uniting them, when they flow to the center of the vessel and pass out through the hole in which the shaft revolves.

Below the soot vessel a short inclined floor is laid, over which the cleaned quicksilver runs down and passes through a gooseneck into a receiver. The soot vessel has the central part of its bottom, about 12 inches in diameter, on hinges. When the soot has been so far cleaned that only a small amount of mercury remains, the shaft is raised, the hinged bottom is opened, and the soot dropped on the inclined floor, from which it is easily taken up by shovels and placed in buckets to be brought back to the furnace from which it originally came. A portion of it is added to every charge of ore, in order to be burned again.

This soot machine requires about 3 horse power, with a speed of from 30 to 50 revolutions. A charge of soot remains about 1.5 hours. The room in which this machine is set up is well ventilated, and the man who attends to all of the work connected with it, that is, keeping up steam, charging and discharging the soot, flasking the quicksilver, etc., is not exposed to any noxious vapors. From June 1, 1888, to September 30, 1889, there were produced in the cleaning of the various condensers 8,191 buckets of soot, to which were added 1,226 buckets of ashes, making a total of 9,417 buckets, or about 4,708.5 cubic feet of soot and ashes worked by the soot machine, from which were obtained 175,969 pounds of quicksilver, or 2,300 flasks and 19 pounds. The total production of quicksilver at the reduction works during these 16 months was 18,346 flasks, from which it will be seen that the percentage of quicksilver cleaned by the soot machine was 12.54 of the total amount of quicksilver produced. The total expenses of condenser cleaning and working of the soot machines during these 16 months was $1,764.15, which gives 1 cent as the average cost per pound of quicksilver obtained from soot. In this estimate the cost of fuel for steam is not included.

Other improvements made include the setting up of a machine for threading flasks and stoppers at the hacienda machine shop in 1886, by which, if necessary, 100 flasks per day can be handled, and old flasks are made serviceable. In 1887 the inclined flue from furnaces Nos. 1 and 2 was extended 270 feet farther up the slope of the adjoining hill, which added much to the general comfort by carrying the smoke to a higher altitude. In 1888 a new water tank of 3,750 cubic feet capacity was erected at an elevation sufficient to provide all the balance hoists with the necessary water, and in 1889 a pump was set up at the water wheel, by which it is worked, pumping water at night, thereby

economizing expense for pumping. In 1888 experiments were made with fuel oil as combustible for the furnaces, but the results were unsatisfactory.

The accompanying drawing shows in detail the plan of the present plant at the New Almaden reduction works.

TRANSPORTATION FACILITIES.

A county road leads from the hacienda to San Jose, a distance of 12 miles. The Southern Pacific Company has 2 railroad branches terminating within 2 miles of the hacienda. The Almaden line of the South Pacific Coast Railway division (narrow gauge) branches off at Campbell station, 5 miles out of San Jose. The Almaden line of the coast division (broad gauge) branches off at Hillsdale, also 5 miles out of San Jose. From Hillsdale to Almaden station the distance is 8 miles, and from Campbell 10 miles. The public wagon road does not extend beyond the hacienda. From the hacienda to the mines on the hill leads a wagon road built with a grade of 9 feet to 100 for a distance of 2 miles to the hill office, and thence 0.5 mile more to Spanishtown. Branches from this road lead to all shafts, the planilla, and the ore bins. The whole length of main road and branches combined is 10.8 miles. Another wagon road leads to the company's woodlands, a distance of 5 miles.

WATER SUPPLY.

The water supply on the hill is derived from 3 sources, springs which furnish between 30 and 55 gallons per minute, or from 40,000 to 80,000 gallons per 24 hours, according to season. The main supply comes from the so-called Black Hills, a part of the coast range of mountains, south of the mines, about 2.5 miles distant. The water is carried in pipes and distributed in water tanks, from which the branch pipes lead to the shaft houses and dwellings. The amount of water stored in the tanks on the hill is 157,400 gallons. There are 8 tanks of 15,000 gallons capacity each, 2 of 10,500 gallons, 2 of 2,700 gallons, and 5 of 2,200 gallons. The main Black Hills pipe and branch pipe lines are composed of 2.5-inch pipe, 4,750 feet; 2-inch pipe, 4,500 feet; 1.5-inch pipe, 4,050 feet, or a total of 13,300 feet, and branches of 2, 1.5, 1, and 0.5 inch pipe, together, 14,800 feet. The total length of pipes is 28,100 feet, or 5.32 miles.

As protection against fire there are 12 hydrants, each provided with 50 feet of hose, distributed at the different shaft houses and in front of the office and store.

The water supply to the hacienda and furnace yard comes from 3 springs and from Alamitos creek. A dam across Alamitos creek diverts the water into a wooden flume 14 inches wide and 12 inches high and is carried through the flume a distance of 2,500 feet to a pressure box at the south end of the furnace yard. From this pressure box a sheet-iron pipe, 14 inches in diameter and 845 feet long, brings the water to the penstock of the overshot water wheel, which drives the machinery of the machine shop, the blower for the blacksmith shop, a 28-inch circular saw for sawing wood, a lathe, and a 16-inch circular saw in the carpenter shop. When not used for this purpose it provides power for a pressure pump, which delivers water by a 4-inch and 6-inch pipe, 650 feet long, into the large water tank as supply for the balance hoists. The water wheel has a diameter of 20 feet, is 6 feet wide, and gives, according to the amount of water available, from 3 to 5 horse power. Surplus water from the penstock of the water wheel passes through 300 feet of 6-inch pipe into a 6 by 12 inch wooden flume 2,813 feet long, that runs along the foot of the hill on the west side of the hacienda village and distributes water for domestic purposes. The water escaping from the wheel runs into a ditch, which carries it along the road through the village and is used for irrigating purposes. The total length of pipe lines is over 8,000 feet, consisting of 6, 4, 3, 2, 1.5, 1.25, and 1 inch pipe.

There are 5 large storage tanks; 2 of these, with an aggregate capacity of 6,900 cubic feet, are located 300 feet above the floor of the furnace yard. These tanks are supplied with water by a spring in Deep gulch, carried by a V flume 1,400 feet in length. The water is used for fire plugs, of which there are 11 2-inch hydrants and 10 1.5-inch hydrants distributed throughout the furnace yard. A tank of 4,530 cubic feet capacity is located on the hill slope west of the furnaces, 80 feet above the furnace floor of Nos. 7 and 9, supplied from the overflow of the higher tanks just mentioned.

SURVEYING.

It is estimated that up to the present time the total distance driven in the New Almaden quicksilver mines, in the form of tunnels, drifts, shafts, crosscuts, inclines, and winzes, is over 46 miles. From ore stopes over 1,500,000 tons of material have been extracted. The bulk of this network of excavations is included in an area 6,000 feet square, and has a vertical extent from the summit of Mine Hill to the lowest level of nearly 2,300 feet.

MINING.

The place of the first prospect work was on the southeast slope and 160 feet below the top of Mine Hill, which is the highest summit of the ridge on which the mines are located. The work of exploration consisted of a tunnel driven into the hill that intersected some of the small veins of cinnabar. The work progressed slowly under the supervision of Castillero and Padre Real, one of his partners in the property, with a few Indians to do the work. In December, 1846, the property was transferred under certain conditions to the firm of Barron, Forbes & Co., of

Mexico. Under the new management the mine was brought into better shape, and it may be said that from that date the mining operations at New Almaden began. The early miners were Mexicans, and the first underground work plainly shows their style of working. The ore was mined without any regular system, being in a great measure taken out by tunnels driven into the hillside, with small upraises or downward inclines that followed the indications of cinnabar, or by shallow shafts that were simply circular holes in the ground, provided with notched timbers for climbing up or down to bring the broken ore to the surface in rawhide baskets, called "serones", that were carried by the miners on their backs, as it is seen to-day in many of the Mexican mines, the load being sometimes as much as 250 pounds. This style of mining was sufficient for the time, as the ore bodies were found near the surface of the ground and were of considerable extent. Neither horses nor mules were employed in hoisting, nor were there any tramways or cars. At the surface the ore was cleaned from waste rock and then carried by mules in sacks down to the reduction works, located on the creek at the foot of the mountain, about 1,200 feet below the mine.

In 1851 a large adit was begun to facilitate the extraction. This tunnel, called the "main tunnel", pierces the hill 320 feet below the summit. It started on a course north 45° west (magnetic) from the south side of Mine Hill (*a*). The tunnel for a double track of cars was made 10 feet wide and 10 feet high, with arched roof, supported by timbers of redwood 6 inches square in cross section. The timber sets were 2 feet apart and covered with lagging. The length of this main tunnel was 807 feet. In front of this tunnel a large level place was constructed with the débris from the mine for a planilla or cleaning floor, on which the ores were cleaned from waste rock and sorted. The ground above this tunnel proved to be very rich in mineral, the ore ground reaching to the very summit of the hill. In it were situated many valuable deposits, known as the "labores" (*b*) of San Rosalio, San Pablo, San Antonio, San Ricardo, and San Pedro, somewhat irregular in their course, but all dipping toward the north and west. These labores proved very valuable and yielded large quantities of high-grade ores. This upper ore ground had an extension of 230 feet wide by 400 feet long, dipping in several ore bodies from the surface to the 300 level.

Following the indications in depth, a shaft was sunk at the distance of 769 feet from the mouth of the main tunnel, called the "main shaft", and provided with 2 compartments, 1 for hoisting and 1 for ladder way. A whim round of 38 feet in diameter, worked by mules, supplied the power for hoisting during the first years, and was afterward replaced by a steam engine supplied with steam by a boiler set up at the mouth of the tunnel. The bottom of the shaft finally reached the 600 level at a depth of 573.76 feet below datum point, or 242.25 feet below the floor of the main tunnel.

In November, 1857, another adit, then called New tunnel, and at present known as Day tunnel, was begun from the northeasterly slope of Mine Hill, at a point 459 feet below the mouth of the main tunnel, for the purpose of draining the ground in the 600 level, which the main shaft had reached, and also to provide a tramway for all the ore coming from this part of the mine. Its progress was stopped by the injunction issued by the United States court, after reaching the distance of 508 feet. The injunction having been raised in 1861, the work on the tunnel was again resumed, and continued with various short interruptions until it had reached a total length of 1,887 feet, at which point it connected with an interior shaft, called the Junction shaft, sunk from the upper works on the 600 level (571 feet below datum). This shaft was started in April, 1862, from the northern end of the ore ground on the 600 level and reached the Day tunnel level on August 1, 1864.

The main shaft had opened up the 10-fathom level (377 feet) (*c*), the 27-fathom level (480 feet), Bestor level (507 feet), and Santa Rosa or 600-foot level (573 feet). Thus far the mine had been opened when the Quicksilver Mining Company became the owners of these lands and mines and assumed the entire control of the works, on November 1, 1863.

The deposits of ore had been explored down to the 600-foot or Santa Rosa level, and great ore chambers developed, of which the most prominent were the San Ricardo (194 feet); San Antonio (214 feet); San Ygnazio and San Clemente; La Cruz, on the main tunnel level; Dios te Guia (400 feet); Far West (400 feet); Ardilla (400 to 500 feet); Ventura (530 feet); Buenos Ayres (560 feet); Marysville (585 feet), and North Ardilla (from 550 to 600 feet). These ore chambers formed irregular excavations, often overlying each other in the vein, which varied in width and inclosed deposits of ore from 10 to 30 feet in thickness, the cinnabar showing an intricate network of veins within the great mass of gangue. The cinnabar veins, called "hilos", when small, often assumed a persistent regularity in a north and south direction, the walls of the gangue, or vein matter, generally being soft or of indurated clay schist or serpentine. The upper portions of the mine above the main tunnel level were nearly exhausted; some of the labores had fallen in, were dangerous to work, and had to be abandoned. The Quicksilver Mining Company also took possession of all the outside mines that extend through their property from Mine Hill northwesterly, a distance of 3.75 miles, on a ridge which runs in that direction.

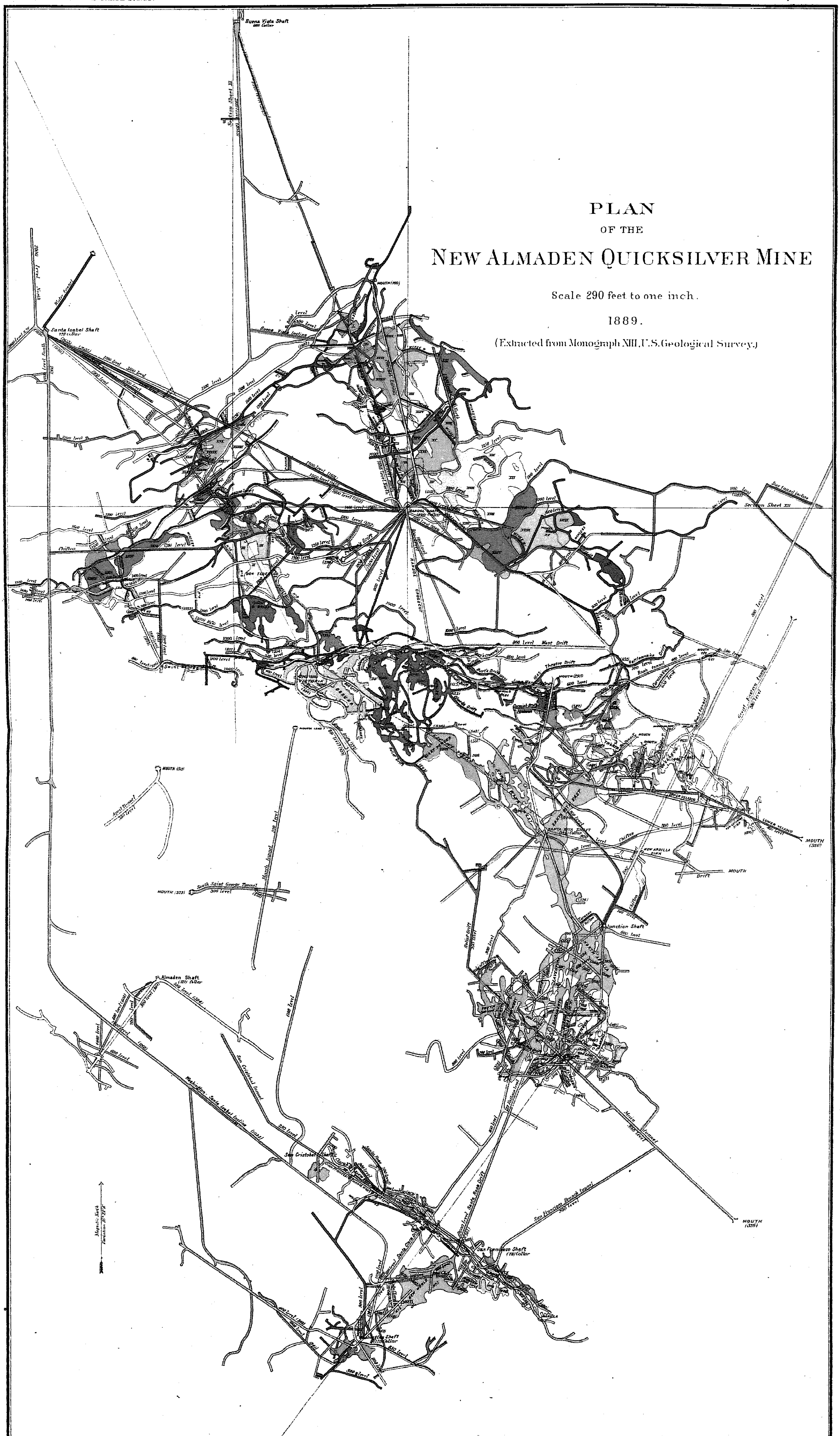
Beginning at the northwest boundary of the company's lands and progressing southeasterly to Mine Hill were

a The summit of Mine Hill is the datum point for all elevations underground or on the surface, the point being marked by a monument set in the ground and covered by an iron cross. The main shaft is almost directly below this monument.

b "Labor", plural "labores", is the Spanish name for "ore stope" or "ore stopes".

c Figures in parentheses are elevations below datum point.

Eleventh Census of the United States. Robert P. Porter, Superintendent.



ENGRAVED BY GEO. S. HARRIS & SONS, PHILA.

the following mines or prospects: (1) the Senador, (2) the Purissima, (3) the San Antonio, (4) the Enriquita, (5) the Providencia, (6) the America, (7) the San Pedro and Santa Mariana, (8) the San Francisco, this last one being on the south slope of Mine Hill, but disconnected from the workings of the main tunnel. There were also a great number of tunnels and prospect shafts scattered wherever indications of ore had been found.

The general outlook was not very encouraging. The total length of all the drifts, tunnels, shafts, and winzes opened in the outside mines amounted to 29,919 feet, not including any of the workings in the Almaden mine proper, opened from the main tunnel and Day tunnel. The great ore bodies had already been systematically worked during 14 years. The great Ardilla labor, one of the largest and richest ore deposits, had been worked out to the northwest, and the mine, having produced so largely for many years, was now confined to a small extent of ground. Other ore bodies were still unknown, and the prospects for the future were doubtful.

All excavations in the mine worked as mineral ground, including ground strictly productive of cinnabar, but not including all the mouths of tunnels and adits, were contained in a parallelogram of 450 by 600 feet.

THE DAY TUNNEL had intersected a large area of barren ground, and was connected with the upper workings in 1871, when it gave facilities for ventilation, transportation, and drainage that were much needed. The principal vein that had been followed northward dipped northward, and it was expected that the continuity of the ore would be found in that direction. A small branch of ore observed in the beginning of 1865 extended northward from the Great Ardilla labor, and widened out and improved gradually until 20 men were here employed in breaking ore. When this ore body finally gave out, in August of the same year, another ore deposit was discovered on the 600-foot level. This ore deposit, called Santa Rita labor, opened out into one of the most valuable deposits ever known in the mines. The ore was of the richest quality, and up to the end of 1867 yielded alone 5,149 tons of ore. The labor extended from the north Ardilla, on the 600-foot level, in a northerly direction and almost horizontally, a distance of 375 feet. Here it divided into 2 branches, one called the Santa Rita East the other the Santa Rita West. The Santa Rita East extended a further distance of about 200 feet, the Santa Rita West more than 300 feet. The width of this large ore deposit varied between 30 and 100 feet, with a height or thickness of ore ground from 20 to 40 feet. The Santa Rita proper, discovered in 1865, became exhausted in 1871, having yielded a total of 11,616 tons of rich ore. The Santa Rita West was discovered in 1868 and exhausted in 1870. It yielded a total of 5,937 tons of ore. Altogether the labores named Santa Rita produced a total of 25,294 tons of ore, that averaged not less than 10 per cent quicksilver.

While these discoveries took place in the Santa Rita ground the other parts of the mine were still worked and produced some ore, and the more prominent labores were some above the 300 level, and below this level the Pruyn, La Cruz, Dios te Guia, 10-fathom and 27-fathom levels, the Collegio, Buenos Ayres, Sacramento, Far West, Santa Rosa, the Velasco workings, and some of the outside mines, all adding their quota to the general ore production. As the works progressed still farther north and extended east and west, the ore bodies grew smaller and more scattering, spread out and dipped more steeply north and west. A notable exception in this general downward dip was the connection with the ore body known as the Velasco group that rose upward and was opened by the Velasco tunnel in 1864 (400 level), and another tunnel called Road tunnel. Both tunnels furnished small deposits of high-grade ores, which reached to the 500 level, and descended from what was known as the Theater labor, worked in 1872, steeply to the 600 level. Here the ore disappeared and only barren vein matter remained.

The northwestern explorations opened up the labores known as the Giant Powder (620 feet), the Ponce (624 feet), the New Santa Rita West (640 to 700 feet), discovered in 1871, the Santa Ana, Ossuna and Victoria (637 to 776 feet). These ore bodies apparently formed the northern boundary of the pay chute. The vein, here smaller in size, took a sudden steep plunge down to the 900-foot level with only small detached ore deposits, and in 1873 the mine gave little promise of continuance.

As the bodies of ore discovered during the past years had continued in their northward course with a dip north and west, the only remedy remained to search for the new ore bodies in that direction and at a greater depth, the Day tunnel being too high for these explorations.

On June 10, 1871, ground was broken for a new working shaft. This shaft, called the Randol shaft, named after the manager of the property, was located on a spur of Mine Hill at an elevation of 426 feet below datum point, 359.5 feet above the mouth of Day tunnel, and about 440 feet north of the rich workings in the New Santa Rita West. The Randol shaft reached the vein 1,151 feet below datum, on the twelfth level. The explorations from this shaft were of the greatest importance for the future of the mine, as they disclosed two prominent ore chimneys, one lying east, the other west, of the shaft. In the western ground they continued almost without interruption from the Great Santa Rita labor (700 level) down to the 2,200-foot level of the mine, while in the eastern ground the ore deposits began at the 900 level and extended to the 1,900 level.

These ore bodies have had a width of 100 to 300 feet, and a thickness from 12 to 20 feet and more, and have up to the present time yielded the regular supply of ore. With this same object in view, other shafts were sunk from time to time and connected by underground workings with the general system from the Randol shaft, viz: the Santa Isabel shaft, started in 1877, reaching down to the 2,300-foot level; the Buena Vista shaft, started in 1882, also reaching to the 2,300-foot level, and the Saint George shaft, in 1887, reaching to the 1,200-foot level. South of Mine

Hill the Washington shaft, begun in 1881, reached down to the 1,100-foot level. The Santa Rita shaft was opened in 1884 as a prospect shaft from the ground above the Santa Rita labor, and sunk to the 900-foot level, piercing through the old Santa Rita labor.

HACIENDA TUNNEL.—The mouth of this tunnel is 1,800 feet south 15° west (magnetic) from the hacienda office in the ravine of Alamitos creek, which flows through the furnace yard of the hacienda. Its mouth is 1,202 feet below the summit of Mine Hill. The course is north 70° 25′ west from its mouth for a distance of 1,848 feet, when it takes a more northerly deviation for 492 feet, then returning again to an almost westerly course for 496 feet; total length, 2,836 feet. The tunnel was started in January, 1867. Its object was to serve as a drain tunnel for the mine and for transportation. After having advanced a distance of 486 feet work was stopped. The developments in the Cora Blanca mine, made in 1874, with a rich ore body in sight, and apparently crossing the hacienda tunnel line, have new encouragement, and the tunnel was continued again in December, 1874, this time with machine drills, to insure its speedy completion into the ore ground of the Cora Blanca mine. In October, 1876, it had reached a distance of 2,135 feet without intersecting any vein. Work was then temporarily stopped, while the Gray shaft was sunk to the 1,000-foot level. The tunnel work was again taken up in January, 1878, and, having reached a total distance of 2,340 feet from the mouth, the direction of the tunnel line was changed to a course of almost due west (magnetic) to intercept the productive vein of the Cora Blanca mine, which indicated a pitch in that direction, and a large vein, 30 feet wide, was intersected, on which branch drifts were run north and south for 130 feet. The indications, however, were so unfavorable that all further progress was stopped in August, 1879.

THE CORA BLANCA MINE.—This mine is situated on the east slope of Mine Hill in a direction a little south of east of its summit and from it about 1,300 feet distant. Its vein is entirely disconnected from the vein system of the main mine, running on a true north and south course and dipping east. The ore deposits were discovered in 1864, and produced 1,800 cargas (*a*) of high-grade ore during the first 3 months. The openings then consisted simply of surface works, opened by tunnels. The ore was found in bunches in a vein close to the surface. These upper works were soon exhausted. In 1873 a shaft was sunk, called the Cora Blanca shaft, collar 574 feet below datum, which struck ore at a depth of 53 feet. Steam hoisting works and a pump were erected. A tunnel that had been started in the ravine, 1,000 feet east from the shaft, called the Deep Gulch tunnel, connected with the Cora Blanca shaft in 1874, its elevation being 770 feet below datum (summit of Mine Hill). In 1875 the Cora Blanca mine produced 6,262 cargas of rich ore. The yield lessened in 1876, the vein becoming much harder below the level of the Deep Gulch tunnel (800 level). Another shaft, called Gray shaft, was sunk in 1876, about 660 feet east of the Cora Blanca shaft, and alongside of the Deep Gulch tunnel, 350 feet from its mouth, to prospect the vein at greater depth. The steam hoist and pump were transferred from the Cora Blanca shaft, and the shaft was continued down to the 1,100-foot level. As all efforts to find ore below the 800 level proved futile, the mine was abandoned in 1879. The Cora Blanca shaft has connection with the 600, 700, 800, and 900 levels; the Gray shaft has stations at the Deep Gulch tunnel level (764 feet), the 900, 1,000, and 1,100 levels (846, 944, and 1,045 feet below datum).

THE SAN FRANCISCO MINE was opened in 1864. It is situated on the south slope of Mine Hill, about 650 feet southwest from main shaft. The vein has a northwest and southeast course, and had originally been opened by 2 adits, the upper San Francisco and the lower San Francisco tunnels. As the work progressed downward the vein improved in character, but the yield was irregular. The workings were connected with the main tunnel by the San Francisco branch tunnel in 1869. The ore production of the San Francisco mine in 1866 amounted to 7,238 cargas, reached 13,686 cargas in 1867, and diminished to 8,661 cargas in 1868. In 1868 a shaft, called the San Francisco shaft, was sunk from the 300 level, and in 1869 connected with the Santa Rosa or 600 level.(*b*) It was provided with a steam hoisting engine, set up at the shaft on the 300 level. The labores on the 300 level and above the Manilla and Arcial on the 400 level and the Warren on the 500 level were the most prominent, the last producing nearly 4,000 cargas in 1871. In June, 1874, the New World labor was discovered from the 600 level. This labor extended 220 feet in length, more than 80 feet in width, with a height from 10 to 20 feet, and produced high-grade ore. From the surface down to the 500 level the vein maintained an almost perpendicular position. The vein of the San Francisco mine has an average width of from 50 to 60 feet. It has been prospected over a length of 900 feet, and was found productive over a length of 500 feet. In the New World labor the vein took a pitch of about 45° southwesterly and finally connected with the 800 level, the Santa Clara, which is a continuation of the Day tunnel. This continuance of the ore body led to the establishment of Washington shaft, first called Garfield shaft, which was begun in November, 1881, at a point 470 feet southwesterly from the San Francisco shaft. The Washington shaft starts from the surface, its collar being 176 feet below the summit of Mine Hill. In June, 1882, 416.5 feet of the 3-compartment shaft had been sunk and met with the upraise, 142.5 feet high, from the Santa Clara drift, a total of 559 feet, then continued down to the 1,100 level, which it reached in January, 1885. The 800, 900, 1,000, and 1,100 stations completed, vigorous prospecting was carried on. However, the ore bodies found were limited in extent and reached only to the 850 level. Below this the vein became flatter and spread out in every

a A carga is a Mexican load of 300 pounds.

b The San Francisco shaft has stations at the 300, 400, 500, and 600 levels, at 320, 370, 465, and 560 feet, respectively, below datum.

direction, while the ore showed only in small branches. The regular prospect work from the shaft was discontinued in the winter of 1887.

THE SAN PEDRO AND SANTA MARIANA MINES have been only superficially developed. Shallow shafts or inclines and prospect drifts of short distances were driven in a very irregular way by prospectors in following the ore indications, and as they were not very encouraging little attention was paid to systematic development. The 2 prospects formed simply an adjunct to the larger mines. In November, 1864, altogether 1,608 feet of tunnels and shafts had been drifted in the San Pedro and 1,547 feet in the Santa Mariana ground. The vein has apparently a connection with the San Francisco vein. The ore production in San Pedro and Santa Mariana virtually stopped in 1868, although small amounts of ore were broken by tributers from time to time in later years.

THE AMERICA MINE, previous to 1864 called "Bull Run", was opened in September, 1863. The mine is situated 1,500 feet northwesterly from the San Pedro workings. The surface of the ground shows much broken vein matter. A tunnel called Upper America, driven 175 feet in length to drain the upper workings, which had started with a small shaft, was completed in July, 1865. Its mouth is on the south slope of the hill, about 100 feet perpendicular below the shaft before mentioned. The ore veins in descending become narrow and almost perpendicular. Another tunnel was started 120 feet lower, called the Lower America tunnel, and driven a distance of 750 feet, as the ore bodies pitched a little to the north. A shaft 216 feet deep was then sunk from the surface. Considerable water was found, and gave much trouble. As the expense of erecting pumping works was not likely to be compensated by the ore in sight, further work was stopped, the engine was removed, and a long tunnel, known as the Great Western, was projected and driven some distance. The ground became very hard, the distance to be driven (1,170 feet) was considerable, and as only 150 feet in depth were gained by it, the work was stopped in 1867. Some metal was broken from the old workings in 1868, 1869, 1873, and 1874 by tributers.

In October, 1885, a new 2-compartment shaft was sunk, with steam hoisting works and pump, about 200 feet southwest from the old shaft. The mouth of this shaft is 147 feet below datum point. It reached the 700 level in March, 1887.

Stations were established at the 500, 600, and 700 levels, at 411, 506, and 601 feet below datum, the 500 level connecting with the lower America tunnel. The developments from these upper levels were unsatisfactory, and the 700 level was very wet. The shaft was sunk 200 feet deeper in the year 1888, with the intention of connecting it with a crosscut from the 1,400 level, Santa Isabel shaft. A large outburst of water injured the shaft in July, 1888, and the unstable character of the ground, combined with the great cost of sinking 400 feet deeper, also the little encouragement which the lower developments had given, resulted in the temporary abandonment of this mine.

THE PROVIDENCIA MINE is about 4,800 feet southwesterly from the new America shaft. It consists mainly of surface works that were opened before 1864. Several small drifts were run into the south slope of the main ridge, which is all vein rock. One, called the Providencia tunnel, 711 feet below datum, reached ore at the distance of 120 feet. Another, the Ravine tunnel, 866 feet below datum, was started in 1864, 155 feet below the Providencia tunnel. Its whole length, straight, is 470 feet, with a branch 142 feet. Some prospecting was done in 1867 and 1871, with poor results. This mine has remained idle ever since. It is stated that it produced several thousand cargas of superior ore.

THE ENRIQUITA MINE is situated 2,000 feet northwest from the Providencia tunnel, on the south slope of the main ridge. The ore body had the shape of a flat arch, its western end with the course north 33° west, the east end south 68° east (magnetic), and a total length of 550 feet, not continuous, but with interruptions in length as well as in depth. This mine was opened in 1859. 3 principal tunnels had been driven—the main tunnel, the Federico tunnel (870 feet below datum), and the Esperanza tunnel, the first one being the lowest. From these tunnels the ore bodies were developed by shafts, winzes, and branch drifts. The upper works being nearly exhausted, the Eldredge tunnel was started in 1863, at the lowest point obtainable in the ravine of Capitancillos creek (1,180 feet below datum), for the purpose of gaining greater depth in the mine and to ventilate and drain the upper works, which had been troubled by foul air and water. In 1865 the Eldredge tunnel had reached a distance of 619 feet; 60 feet were added in 1867. The work was continued in later years from time to time until, in 1874, the tunnel had reached a total length of 875 feet. In 1874 work was again resumed in the upper mine, and prospecting was done in the San Andreas ground, where 282 feet were drifted. Very little ore, however, was found. At the end of March, 1875, all work was discontinued at the Enriquita mine, as the low prices of quicksilver did not encourage prospecting at a point so remote from the general works.

THE PURISSIMA MINE was worked to a small extent in 1860, and it is said that rich ore was found. In 1864 the whole prospect work aggregated 194 feet of drifting and sinking.

The San Mateo shaft of this mine, which lies about three-quarters of a mile northwesterly from the Enriquita mine, was sunk in 1874 through ore ground a distance of 87.5 feet. The ore, however, appeared only in small branches. Further explorations were stopped for the same reasons which led to the suspension of work at the Enriquita.

THE SAN ANTONIO adjoins the Purissima ground on the east; development, 588 feet of drifting and sinking.

THE SENADOR MINE is nearly 1 mile northwest from the San Mateo shaft on the north slope of the ridge, and within one-quarter of a mile from the western boundary of the company's lands, adjoining here the lands of the Guadalupe Mining Company. A small shaft and tunnel were driven and sunk, and some 400 cargas of good ore were taken out. A tunnel 40 yards lower in elevation was driven in 1873. No work has been done at this mine since then, when the total length of drifts and shafts amounted to 480 feet.

The illustration of the underground workings shows the present condition of the New Almaden mine. The table following gives the co-ordinates and elevations of the different shafts and tunnels, the datum point for co-ordinates being a point 30 feet distant on the line and outside of the Hacienda tunnel, marked by a monument post. The datum point for the elevations is a monument on the summit of Mine Hill, from which all levels on the surface as well as underground have been determined. This point is 1,755 feet above sea level.

CO-ORDINATES, ELEVATIONS, ETC., OF PRINCIPAL SHAFTS AND TUNNELS.

[Feet.]

No.	SHAFTS AND TUNNELS.	CO-ORDINATES FROM MONUMENT H.		Elevation of collar of shaft below datum point.	Lowest level opened.	Absolute depth from surface.
		North.	West.			
1	Main shaft (*a*)	1,760	4,945	317	700	345.0
2	Randol shaft (*b*)	3,535	5,445	426	1,800	1,340.0
3	Santa Isabel shaft (*b*)	4,105	6,595	728	2,300	1,526.0
4	Buena Vista shaft (*b*)	5,060	5,990	885	2,300	1,375.0
5	Saint George shaft (*a*)	3,020	6,240	570	1,200	548.5
6	Almaden shaft (*b*)	1,990	6,245	275	700	484.5
7	Santa Rita shaft (*a*)	2,480	5,015	125	900	761.5
8	Washington shaft (*b*)	830	5,605	176	1,100	880.0
9	San Francisco shaft (*b*)	1,130	5,245	78	600	485.0
10	Cora Blanca shaft (*a*)	1,575	3,565	574	900	275.0
11	Grey shaft (*a*)	1,390	2,925	618	1,100	457.5
12	America shaft (*a*)	2,240	8,195	147	700	809.5
A	Main tunnel	1,245	4,380	326	(*c*)	.....
B	Day tunnel	3,880	4,000	785	(*c*)	.....
C	Hacienda tunnel	25	70	1,202	(*c*)	.....
D	Deep Gulch tunnel	1,395	2,575	770	(*c*)	.....
E	Randol crosscut	4,245	5,555	760	(*c*)	.....
F	Great Eastern tunnel	3,240	4,190	528	(*c*)	.....

a Closed. *b* Open. *c* At mouth.

The Junction shaft goes from the 600 level (Santa Rosa) to Day tunnel, or 800 level; co-ordinates, 2,170 north and 4,810 west.

The shafts of the outside mines are not comprised in this list; neither are the tunnels, as they are of little importance now. The above shafts are those that are or have been provided with steam hoisting works. Those mentioned as opened are in first-class working condition at present date. The tunnels or adits are all open, with the exception of the Hacienda tunnel.

The main horizons or levels are opened from these shafts at distances of 100 feet, more or less, perpendicularly, the absolute elevation being determined by local necessities, as connection with levels from other shafts already opened, or with adit tunnels, etc.

The aggregate length of all shafts, winzes, drifts, tunnels, and crosscuts was 46.35 miles at the end of December, 1889, not including many prospect drifts that were run during the first few years of mining at Almaden and Enriquita, as no record has been kept of these places.

The usual method of prospecting for ore during the first period of mining at Almaden, that is, from 1845 to 1870, nearly, consisted in crosscutting the vein and then following the indications of the small cinnabar veins, called by the Mexican miner "hilos", that usually led to larger deposits. This method was followed in the upper portions of the vein, where the ore bodies occupied all possible positions, sometimes near the middle of the body of vein, sometimes near the hanging wall. Later explorations in depth demonstrated, however, that ore bodies almost persistently followed only the contact of the hanging wall (called "alta" by the Mexican miners) with the vein. The explorations, therefore, were always along the alta wall of vein, no matter how tortuous the direction might be. The ore ground above the 800 level was much more irregular and scattered than that below this depth, where 2 prominent ore chutes were developed, which could be relied on with almost positive assurance within certain limits. One of these chimneys, or ore chutes, is situated on the northeast side of the Randol shaft, the other on the southwest side, and they have been commonly called the north and south veins. The north vein has continued without interruption from the 900 level to the 1,900 level as ore bearing, but has been opened as far as the 2,300 level, the latter distance being barren. The south vein has continued, without any interruption whatever, as an ore-bearing vein from the top of Mine Hill down to the 2,200 level, a total distance,

measured on its dip or slope, of nearly 3,800 feet. Below the 2,200 level this vein has proved barren. Branch veins were found in the hanging ground of these main veins, on the north vein as well as on the south vein. Their extension upward or downward, however, is not continuous, and the ore bodies were developed by crosscutting from the main levels. This second vein system is so irregular and uncertain that no reliance can be placed on its being met with by crosscuts. It is only by a very broad and general comprehension of the vagaries of the cinnabar ore bodies that anything like a favorable result might be anticipated. This must explain the enormous amount of underground work done in these mines. The ground explored by the different shafts, including the Washington and Cora Blanca, occupies an area of over 1 square mile.

The early developments of the New Almaden mines were by adits and small shafts, as they are commonly used by the Mexican miners, who were the first laborers employed. The unknown structure of the vein and its apparent irregularity made it difficult during the first period of mining to decide upon a system to be followed throughout. The introduction of English miners (Cornishmen) brought about a decided change in the methods of working, and the use of steam hoisting works and pumping engines obliterated all differences that might have existed in the deep mining employed at New Almaden and elsewhere. Some local customs and arrangements exist, however, and to explain all these a full description of the methods of mining as pursued at New Almaden will be given in the following pages.

At the present day ore is brought to the surface from great depths, and the underground work is entirely done through shafts. From these shafts levels are excavated at regular intervals of about 100 feet. From these levels the prospecting work is prosecuted by drifting, sinking, or upraising, as circumstances may require, along the vein, or crosscutting the hanging wall or foot wall in search of other veins or ore bodies. These explorations are not confined to one level at a time, but include several. The ore bodies when found are usually extracted by stoping out overhead, although underhand stoping is often resorted to.

SHAFTS.—The shafts resemble each other in general features. They are vertical and timbered throughout. The size of their timbers and the distance between sets of timber vary according to the size of the shaft and the nature of the ground through which they have been sunk.

The Randol is the principal working shaft, and has held this place during the past 16 years. It has only 2 compartments, one for hoisting, the other originally for pump work, but at present only used for ladder way. Its size is 4 by 9 feet in the clear, the hoisting compartment being 4 by 4 feet, the pumping compartment 4.5 by 4 feet, and a 6-inch partition between the 2 compartments. It is closely cribbed with 8-inch timbers from top to bottom. The collar of the shaft is 426 feet below datum point. Its actual depth to the bottom of the sump is 1,340 feet. Beginning at the 800-foot station (758 feet below datum), connected with the surface by an adit level, the Randol crosscut, the shaft is provided with stations at every 100 feet of depth, the lowest being the 1,800-foot station, and level, at 1,751 feet below datum.

The Santa Isabel shaft has 3 compartments, 2 for hoisting and 1 for pumping. The shaft is 13 feet 8 inches long by 4 feet 6 inches wide in the clear, each hoisting compartment being 3 feet 8 inches by 4 feet 6 inches; the pump compartment 5 feet by 4 feet 6 inches. The partitions between the compartments are 8 inches thick. The timbering consists of open sets of 10-inch timber with lagging from the collar down for a distance of 60 feet, followed by close cribbing with 8-inch timbers for 240 feet; then again open sets of 10 by 10 inch timbers, and farther down of 10 by 12 inch timbers. The open sets of 10-inch timber are 3 feet between centers; the 10 by 12 inch sets are placed at 3 feet 6 inches between centers. The pump compartment also contains the ladder way. The collar of the shaft is 728 feet below datum; the actual depth to bottom of sump is 1,526 feet. From this shaft stations are established at the 1,400, 1,700, 1,900, 2,000, 2,100, 2,200, and 2,300 levels, represented, respectively, by 1,303, 1,653, 1,856, 1,957, 2,035, 2,134, and 2,234 feet below datum point.

The Buena Vista shaft is 5 by 15 feet clear inside of timbers, and has 2 hoisting and 1 pumping compartments. Each hoisting compartment is 3 feet 8 inches wide. The pump compartment is 6 by 5 feet, and is provided with ladder way. The shaft is closely cribbed from the collar down for 50 feet with 12-inch timbers. Then follow open sets of 12 by 12 inch timbers, 3 feet between centers. The partitions are 10 inches thick. The collar of the shaft is 885 feet below datum point, the bottom 2,260 feet below datum, or 509 feet below sea level, making a clear depth of shaft of 1,375 feet. An adit level connects with the shaft 306 feet below the collar, used as drain level for the water raised by the pumps. Only 2 stations are established in this shaft, 1 at the 2,100-foot level (2,046 feet below datum), and 1 at the 2,300-foot level (2,246 feet below datum). Explorations below the 2,100-foot level having been suspended, the shaft has filled with water to that level.

The Saint George shaft is 4 by 8 feet in the clear, with 1 hoisting and 1 ladder-way compartment. Its total depth is 548.5 feet, including the sump. The collar of the shaft is 570 feet below datum point. The timbering consists of open sets of 10 by 10 inch timber, 3 feet between centers. Stations have been established at the 800 level (750 feet below datum), the 1,000-foot level (930 feet below datum), and the 1,200-foot level (1,105 feet below datum).

The Almaden shaft is 4 by 9.5 feet in the clear, with 1 hoisting and 1 pumping compartment, the latter containing at present only a ladder way. The shaft is timbered with open sets of 10-inch timber, 3 feet 3 inches between centers. The collar is 275 feet below datum point, the bottom at 759 feet; total depth, 484.5 feet. Stations have been established at the 500, 600, and 700 levels. This shaft is not connected with the other parts of the mine.

The Washington shaft, 4 by 14 feet in the clear, has 3 compartments, 2 for hoisting and 1, originally used for pumping, containing now only the ladder way. Its collar is 176 feet below datum point. The levels established are the 400 at 368 feet, the 800 at 741 feet, the 900 at 841 feet, the 1,000 at 941 feet, and the 1,100 at 1,041 feet below datum. There is also the 850-foot level at 795 feet, but without station at the shaft and connected by a short crosscut only. The total depth of the shaft from collar to bottom of sump is 880 feet.

The Santa Rita, America, Cora Blanca, Gray, and Main shafts are 2-compartment shafts.

The San Francisco was originally an underground shaft, and has only lately been driven to the surface, its collar being now at 78 feet below datum point, while originally it only started from the 300-foot level (320 feet).

The Santa Rita shaft was begun in December, 1884, for the purpose of prospecting the ground above and below the old Santa Rita labores. It reached its total depth of 761.5 feet in March, 1886. The greatest depth sunk in 1 month in serpentine was 150.5 feet. Its collar is at 125 feet below datum. The shaft is connected with the Juan Vega tunnel (300 level), the 800 level, 780 feet below datum, and has a station and level at the 900 (880 feet below datum).

The Main shaft starts from the 300 level (main tunnel) and has stations and levels as follows: 10, 20, and 27 fathom levels (at 380, 445, and 482 feet below datum), Bestor's level (at 510 feet), the Santa Rosa or 600 level (at 571 feet), the Little Plat level (at 600 feet), and the Relief or 700 level (at 667 feet below datum).

The America, Cora Blanca, and Gray shafts are timbered with open sets of 10 by 10 inch timbers, 3 feet apart, the partition timbers being 6 by 8 inches in section.

SHAFT TIMBERING.—The timbering of the shafts is done from the surface downward as the sinking progresses. Sawed redwood timbers are used for the framework of the sets. These sets are secured horizontally, either close together in very heavy ground (cribbing), or at certain distances from each other (open sets). The open sets are kept apart vertically by posts or studdles at their corners. Between the sets the ground is covered by lagging 3 inches by 6 inches in section, placed upright, and secured tightly against the timbers by wedges driven between the ground and the lagging. Cross-timbers for the partitions form a part of every set.

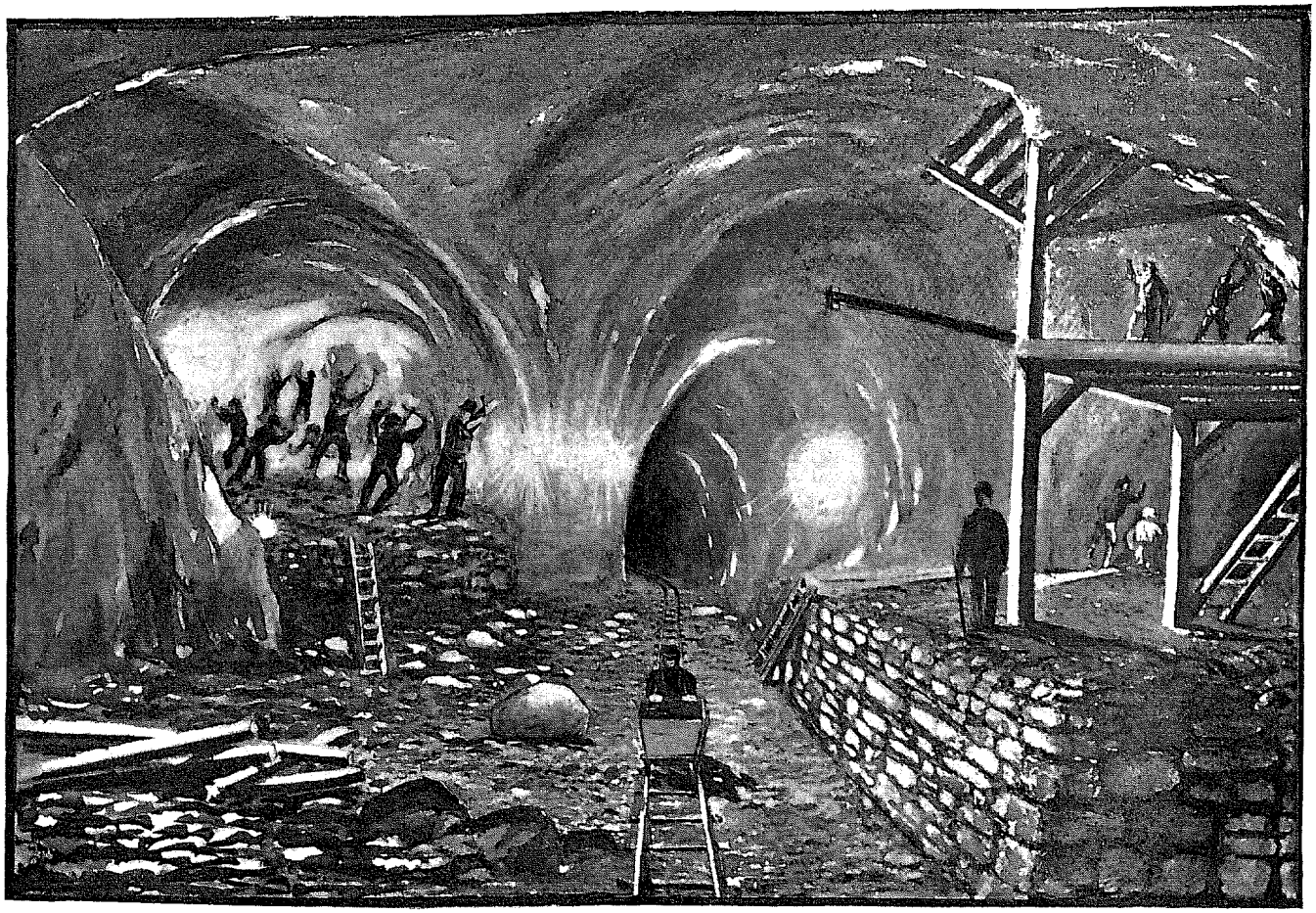
The sizes of the timbers forming the sets are selected according to the size of the shaft and the nature of the ground, which also control the distance between the sets. The posts, or "studdles", as they are called, have simply squared ends, and after being placed in proper position are secured with heavy nails.

In the solid cribbing the end timbers rest against a 1-inch shoulder of the long pieces only. The timber sets for winzes of ordinary size are similarly framed, with shoulder joints at the corners and studdles to keep them apart, and lagging where necessary. This style of framing is changed in winzes that have more than one compartment, and in heavy ground when the timbers are framed like shaft timbers and provided with partitions.

When sufficient ground has been excavated to place a new set, the end timbers are first lowered down and put approximately in place by hanging them from the last set above. Round iron rods, with nuts and washers at one end and a hook at the other end, are passed through holes and secured by nuts in the last set above. Similar rods are passed through the new end pieces and hooked to the rods from above. The long sides of the frame are then lowered in place and the studdles secured in the 4 corners. The iron rods are then screwed up tight, when the new set is firmly held by the one above. The lagging is then put in place and nailed to the timbers, wedges driven firmly between the rock walls and the lagging, and the partitions put in place. When so arranged the new set is held in place by the lateral pressure of the ground, and the iron rods connecting the sets can be withdrawn after a time, although it is usual to keep them in place for 3 or 4 sets above the last one. Every 30 or 40 feet or so the end pieces of the sets rest upon other timbers, called bearers, that are made longer and have their ends for a certain depth supported in holes excavated in the wall rock at the proper distances. This depth depends upon the nature of the ground, being only about 4 inches in hard rock, and sometimes as much as 2 feet in soft ground. When the ground is too soft, or liable to give way, the bearers are omitted until firm ground is reached. Timber sets so adjusted last for many years, and with proper attention require very little repair. Should a set become broken from any cause, pressure of the ground or otherwise, or be forced out of the general alignment, it can be taken out and readjusted without much difficulty. In very heavy ground this method of timbering is replaced by solid cribwork, in which one set rests upon the other. Here the iron rods are dispensed with, and the sets are built up from below, precaution being taken to have sufficient space for the sets between the one first secured in the bottom and the others that are to follow on top to inclose the sides, the last remaining space being filled in by a piece of board, wedge-shaped to the required size and driven firmly between the sets.

Small prospect shafts have their sides timbered with 2-inch planking, no other timbers being used, except a few open sets near the surface of the ground. In this case the planks are sawed to proper lengths and placed horizontally with their faces against the sides of the shafts, the end planks being secured by pieces of 1 by 6 inch boards, nailed against the long sides to prevent the ends from being forced in. Wedges hold these planks firmly in place. The partitions are also made of 2-inch plank secured by 1 by 6 inch pieces. The planking is done from time to time as the depth of the shaft increases, and then from the bottom upward, as in cribwork.

The stations in the shafts from which the different levels start are chambers excavated, and timbered if necessary, extending the whole length of the shaft, usually 16 feet deep, and consist of 2 floors, called the upper and lower plats. The upper plat has its floor on a level with the car track of the drift starting from the plat, while the



FRANCISCO VELASQUEZ CHAMBER; A RICH ORE BODY IN 1865, AT NEW ALMADEN.

From a drawing by J. Ross Browne.

lower plat furnishes dumping room for the material to be hoisted to the surface. The upper plat is 7 or 8 feet high in the clear between the timbers. The dump plat has a capacity for about 30 tons of rock, which is dumped by the cars through an opening between the rails over the whole length of the plat. The upper plat is used for landing timbers and supplies or tools sent into the mine.

In opening a station for a new level, one of the long sides of the shaft sets adjoining the station with its lagging is taken out for the entire height of the 2 plats, and heavy upright timbers are inserted at the 2 corners of the shaft timbers and one opposite each partition, to take up the pressure of the other side. These timbers are called "brow pieces". The roof of the stations is either left unsecured (when in solid rock) or is timbered with horizontal or arched timbers, as the case may require, and is covered by lagging. The upper and lower plats have floors of 3-inch fir planking, that of the upper plat resting on 12-inch timbers or joists.

All the shafts and winzes are provided with ladder ways. The ladders have 2 by 4 inch redwood scantlings for sides, each piece 15 feet 7 inches long. The distances between the sides is 10 inches in the clear. The rounds of the ladders are 11 inches apart, made of five-eighth-inch round bar iron. The third round from each end of the ladder is made of three-quarter-inch round bar iron, with shoulders or bosses that abut against the inner side of the spars, and nuts screwed on the ends of these bars to prevent the spreading of the sides. In putting ladder ways in perpendicular shafts or winzes, 2 ladders are joined together at the sides by a piece of scantling, and, having the upper end secured to the shaft timbers by iron clamps, stand with their lower end upon small platforms built across the shaft, which gives them sufficient slope for greater ease in climbing. The next pair of ladders starts either from the same side of the shaft or from the opposite side, the head of the second ladders projecting sufficiently above the platform to afford a hold while the next step is taken. Inclined winzes have platforms at every second ladder when the winze is not used for other purposes, or have a continuous line of ladders if space should be required for hoisting or lowering.

TUNNELS OR DRIFTS.—The usual size of all drifts or tunnels is 7 feet high by 5 feet wide in the clear. In hard rock, which requires no supports to hold it in place, this cross section is of course irregular, but whenever the nature of the ground makes timbering necessary the cross section is obtained by the clear length of the timbers. The top or cap piece which supports the roof is 4 feet long in the clear, and the posts or legs are each 7.5 feet long in the clear, spreading to a width of 6 feet at the bottom. 2 posts or legs and a cap form a set of timbers. These are set from 3 to 5 feet apart, according to the nature of the ground, and covered with lagging on the roof and sides when the ground requires this precaution. The lagging is 3 by 6 inches in cross section, and of suitable length to cover the space between the sets. In drifts where a good solid vein is followed it is usual to dispense with 1 leg of the set, as the vein is hard enough to stand without breaking, and only the hanging-wall side and the roof have to be supported. The timber used is redwood, hewed to different sizes. The dimensions are selected according to the nature of the ground. The largest size timbers are 16 by 16 inches square, the smallest 8 by 8 inches. Round timber has of late years been used, as it is somewhat cheaper, and the round sticks are often split in two in making sets for drifts. The lower ends of the posts are simply placed on the floor without sills. A piece of lagging of proper length is usually wedged and nailed between the upper ends of the 2 adjoining sets to keep the sets apart and transfer the pressure of the ground against one set to the neighboring sets. The lower ends of the posts do not require this precaution, as they are set in the ground a few inches and so are firmly held.

The grade or inclination of the floor of the drifts or tunnels is about 1 foot in the hundred in all drifts following the vein, where they are usually very tortuous. Straight tunnels, adits, or crosscuts of greater length have an inclination of only 3 or 4 inches to 100 feet. All drifts or levels are provided with tracks of steel rails, joined by fish plates and resting on crossties of redwood 4 by 6 inches in section, 4 feet long. 90 per cent of all drifts and tunnels require timbering to prevent the caving in of the sides and roof.

The excavating of drifts and shafts is usually done by hand drills. The Santa Isabel and the Buena Vista shafts have been sunk largely by machine drills; so also all the long crosscuts underground.

ORE EXTRACTION.

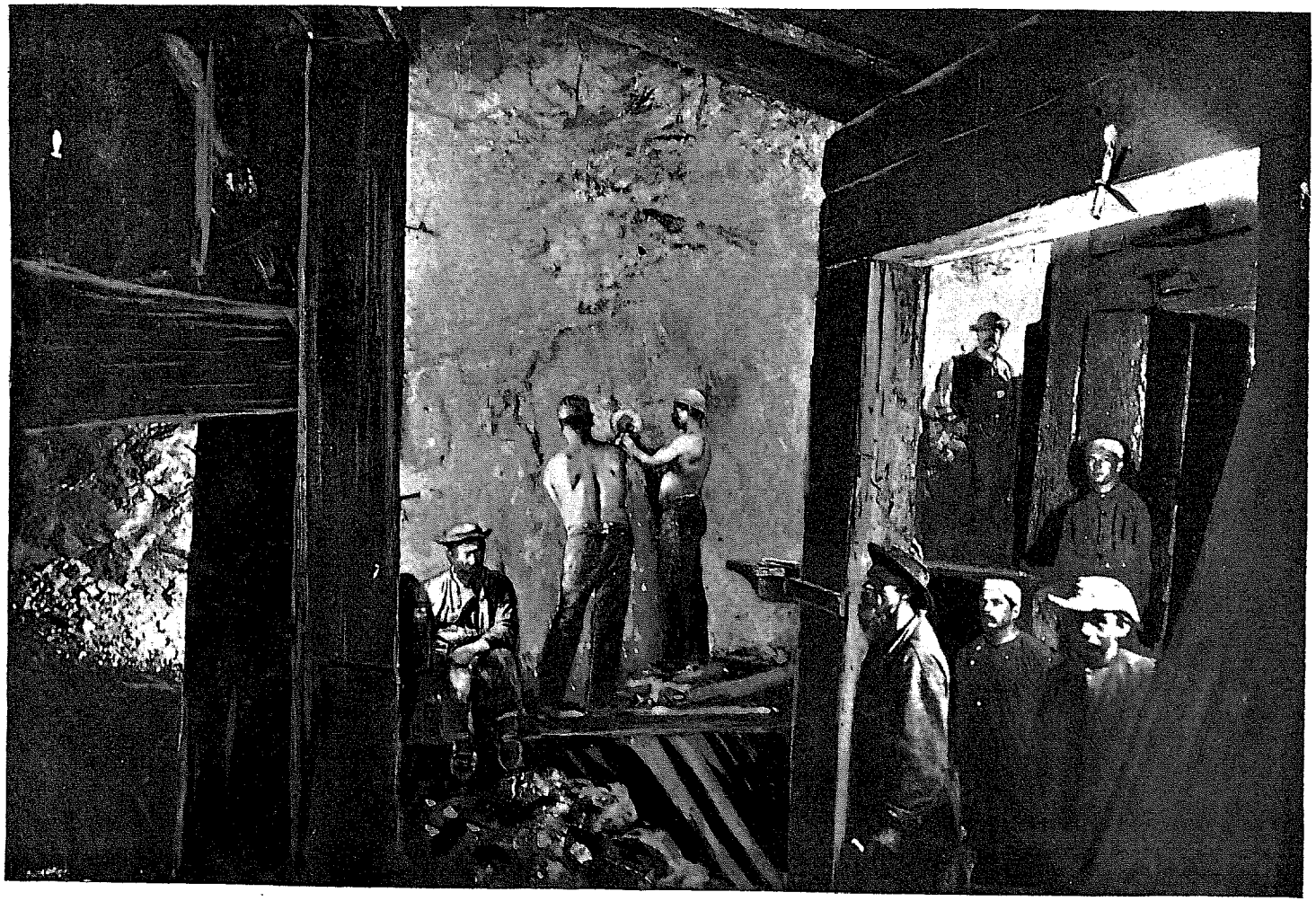
The ore deposits having been reached by the drifts or crosscuts, their removal is accomplished in the following manner: The face of the vein rock is blasted out as far as the ore deposit reaches back into the vein, the floor being kept level with the drift. The deposits of cinnabar generally follow the hanging wall or alta, and vary in thickness from a few to many feet. As all the rock that contains cinnabar is broken out there is a large cavity left of irregular form, with sloping bottom and sloping, overhanging roof. The roof being formed of the hanging wall, which is mostly a shaly formation, is sometimes hard, but often very soft and clayey, and timbers have to be inserted for its support. The regular plan followed in stoping and timbering these ore excavations is by breaking the vein upward (overhead stoping) from the bottom of the level where the stope commences for a horizontal distance of about 4 feet, when, after squaring the face of the stope, the timbering, consisting of posts, caps, and lagging, is put in to secure the roof. In this way the ore is followed up as far as it reaches, and the timbering is continued as the excavation proceeds. The ore deposits being very irregular in form, it follows that the timbering is also very irregular in arrangement. A set of timbers usually consists of 2 legs or posts, a cap, and lagging,

or, in very heavy ground, split timber, to support the roof. 2 auxiliary uprights or posts are put in place first, reaching from the bottom of the excavation to its roof and placed in a position normal to the pressure of the roof. Small channels from 4 to 6 inches deep, called "hitches", are cut in the foot wall for these auxiliary posts to secure them against the force of blasting. These posts are of different sizes, according to the nature of the roof, and usually 12 by 12, 14 by 14, or 16 by 16 inches thick. They are sawed off at proper lengths to reach the roof of the labor, against which they are tightly wedged. Parallel with the face of the labor they are usually 12 feet apart and 3.5 feet in the other direction. Against the inward side of these timbers, toward the face of the labor, the regular sets are placed, long enough to admit on the top the caps, which are also of heavy timbers from 12 by 12 to 16 by 16 inches thick, and on top of these caps, reaching from one set to the other, is placed the lagging or split timber to support the roof. In some cases 2 or 3 caps are laid on top of each other to support the heavy pressure of the roof, and the uprights sometimes consist of 4 posts, each 16 by 16 inches thick, bolted together with three-quarter-inch round iron bolts, forming a solid column of timber 32 inches square. Even this method is sometimes insufficient to withstand the great pressure, and solid cribwork of heavy timber has to be substituted to support the roof. Whenever possible waste rock is piled up in the form of pillars or walls, which, when well laid, is the best protection against pressure, although the steep slope of the ore bodies makes this method impossible in most cases.

The character of the vein is such that the ore can not be extracted without the aid of powder, and for this purpose, if possible, black powder is used, in order to prevent too much fracturing of the ore into very fine stuff. In very hard siliceous veins, however, dynamite powder is used; also when large fragments of rock have to be blasted, or in making room for timbers and in wet holes. The faces of the labores advance upward with a breadth of 20 to 50 feet, and if any ore remains at the sides it is taken up after the first stope upward has reached the level above, or it is taken up in steps all around as the work progresses. The main object is to keep a central place for the delivery of the broken ore into the cars, which would be more difficult if the whole face of the ore body were advanced upward at once. Pillars are not left in the ground, although with a very extended ore body (they are from 100 to 300 feet in length at times) it is usual to start the stopes from 2 or more places at once. The sorting of the ore is not done underground, excepting that large fragments of barren rock are left behind and piled up in places where they are out of the way. The filling in or stowing of the exhausted labores with waste rock is seldom resorted to on account of the irregularity of the stopes and the great expense incurred in tramming the rock to the required places. Old exhausted labores, however, are used as dumps for the waste rock from prospect drifts. The caving together of old labores, should it happen, does not cause any inconvenience, and most of the ground has been accessible after 10 years and over.

Two systems are employed in extracting the ore, (1) the footage system, and (2) the tribute system. The footage system is usually employed in new labores; that is, in such as have been recently discovered. The miners are paid by the depth of the bore holes drilled, the contract for each labor being awarded to the lowest bidder per foot. The number of men forming a company for 1 labor ranges, according to the size of the labor, from 4 to 20 or more. The men work in 2 shifts of 10 hours each, commencing work at 7 o'clock in the morning and 7 o'clock in the evening, respectively. These shifts are under the control of a foreman employed by the Quicksilver Mining Company. He is called the "blaster", and receives his orders from the mining captain. The blaster determines where the holes shall be drilled, in what direction, and to what depth. Beginning at the commencement of the shift and continuing for about 4.5 hours, each party of 2 miners will probably drill 6 to 8 feet of holes of 1.25 inches in diameter, or during the whole shift of 10 hours probably from 6 to 12 holes. The first part of the work is finished at about 25 minutes to midnight or midday, as the case may be, when a rest is taken for lunch. The blaster measures then the depth of all the drill holes and keeps a record of these figures, which constitute the earnings of the men. He hands to the men the powder can, and directs how much powder is to be used for each hole. After all the holes have been properly charged and tamped he gives the order to fire. The candle snuffs under each fuse are then lighted, and the men retire to a safe place. The number of blasts are carefully counted as they go off, so as to be sure that all charges have been exploded. In case a hole misses fire it becomes the duty of the blaster, after a delay of 30 minutes, to return to the drill holes and to find the unexploded charge. The hole is refired if it is found that the fault has been in the candle going out before setting fire to the fuse; but should the fuse have been burned without communicating the fire to the charge, then the hole is left untouched for 24 hours, and the men in the vicinity are warned to be careful. After 24 hours' time the charge is carefully picked out, and the hole is recharged and fired if necessary.

In the tribute system a company of miners, having selected some part of the mine to extract ore from, usually one of the abandoned stopes of former years, apply for a private contract to work it. They attend to all the different operations of mining, that is, stoping, drifting, blasting, and timbering, at an agreed price per ton of ore extracted. These contracts are given only for 1 month at a time and are renewed from month to month. The superintendent of the mine reserves the right to state the number of men that shall be employed in the work. The detail work is generally under the supervision of the mining captain, in order that the ground may be explored to the best advantage. The transportation is done by the Quicksilver Mining Company. Tools and timber are also furnished, the tributers supplying only powder and light.



STOPE OR "LABORE," NEW ALMADEN QUICKSILVER MINE.

TRAMMING.

The waste rock from prospect drifts and winzes, crosscuts or upraises, if not used in filling up abandoned stopes, is brought in cars to the shafts where it is hoisted to the surface. The ore from the labores is transported in the same way. Care is taken to keep the ore separated from waste rock, and to keep separate the ores coming from the company's labores as well as those coming from the different tributers' labores, as the account of each tributer company must be kept distinct.

In the Randol mine, where many shifts of miners are working in prospecting or tribute work, and where many labores are being stoped, tramming is continued day and night. This work is awarded by contract to the lowest bidder per ton. A company of 4 or 6, sometimes 8, men takes the contract for tramming on several levels that can be worked together conveniently. In those parts of the mine where only 2 or 3 drifts or labores are being worked and the distances to be trammed are short the miners do their own tramming. In tramming, 2 men usually attend to a car that holds 1 ton of rock or ore. They fill the car at the ore stopes or at the pile of waste rock that has been thrown back by the miners.

On the 1,400-foot crosscut south from Santa Isabel shaft, which is over 2,600 feet in length, and in the Day tunnel, which is also of great length, the tramming is done by mules. The mules that work on the 1,400 crosscut from Santa Isabel shaft are stabled underground. The tramming from the Randol shaft on the 800-foot crosscut (adit) is done by mules to bring the hoisted material, ore, or waste rock from the shaft to the surface. 1 mule pulls a train of 2 cars, and is attended by a driver.

CARS.—Those used in the Randol mine are 5 feet 6 inches long inside the box, 2 feet 3 inches wide, and 1 foot 10 inches deep, holding from 1,600 to 2,000 pounds of rock or ore. The box is made of pine planks, the sides 1.5 inches thick, the bottom 2 inches thick, lined with quarter-inch sheet-iron plate on the inside. The upper edge is also protected by strap iron screwed on. The box has a hinged door in front hung on a 1-inch round bar of iron. This door is kept closed by a hook at the end of an iron bar which runs along the bottom of the car, and is opened or closed by turning the handle at the rear end of the car box. The trucks are made of 4 by 10 inch pine lumber, and provided with cast-iron wheels 14 inches in diameter. These cars dump only in front.

In the Day tunnel and the Randol adit (800 crosscut) cars of the largest size are used, as they are trammed by mules. These car boxes are also of wood, but measure inside 6 feet 2 inches in length, 2 feet 6 inches in width, and 2 feet deep. They have a capacity of 3,000 pounds. In construction they resemble the cars used in the Randol mine, except that they are provided with brakes worked by foot power from the rear end of the car.

At the Buena Vista shaft, where the cars are hoisted to the surface, they are made of three-sixteenth-inch sheet-iron boxes, 3 feet 8 inches long, 26 inches wide, and 2 feet deep. They dump in front or at the sides, as required. The truck is framed of timber and rests on 12-inch cast-iron wheels. One wheel of each pair is keyed to the axle, while the other revolves freely. The axles are of 1.25-inch round steel, revolving in cast-iron boxes. The cars weigh 600 pounds empty, and hold about 1,200 to 1,500 pounds.

The gauge of the tracks is 24 inches in the Randol mine, 30 inches in the Day tunnel and Randol adit, and 20 inches in the Buena Vista, Almaden, Saint George, and San Francisco. One man, called the track layer, with an assistant, attends to all the laying and repairing of the tracks. The rails now used in the mine are of steel, weighing 12 pounds to the yard. The total length of all underground railroads, including the tracks leading from shafts to ore and waste dumps, is 35,000 feet, in round numbers.

HOISTING.—The ore and waste rock from the Buena Vista shaft is hoisted to the surface in cars on double-deck cages, provided with tracks for this purpose. There are consequently no dump plats in the Buena Vista stations. The cars while on the cage are held in place by hooks, which are dropped into staples riveted to each side of the car. All the other shafts are provided with skips for hoisting the ore and waste rock. The skips are rectangular boxes made of quarter-inch steel plates, stiffened at the corners by 2-inch angle iron, to which the sides are riveted by half-inch rivets driven from the inside. The inside dimensions of the horizontal section of the skip are 2 feet 8.5 inches by 2 feet 7 inches. The front side is 6 feet 3 inches long on the outside, while the rear side is only 3 feet 7 inches long, which gives the skip a sloping bottom. The lower end of the front has a hinged door 2 feet 4 inches high, covering the whole width of the skip. This door is closed by a latch bar 3 inches by five-eighths inch extending across the front and dropping into catches projecting from each side of the box, and is kept locked by a movable key or pawl which hangs above it. A piece of angle iron riveted to the bottom of the box, on the outside near its front edge, serves for a shoulder to rest against the apron or door of the shaft while unloading. The guide frame or bale of the skip is made of three-quarter-inch iron, 4 inches wide, riveted to the sides of the skip by rivets driven from the inside of the box. The transverse bar on the upper end of the frame or bale is of wrought iron 1 inch thick and 3.5 inches deep, with flanges at each end and bolted to the guide frame. From the transverse bar down along each side of the frame to the lower end of the skip box extends a guide strap 4 inches wide, one-fourth inch thick, fastened to the frame and skip box 1.25 inches from the face of the box, which brings the outside faces of these guide straps 2 feet 11.5 inches apart and leaves one-half inch for play between the guide rods. Near the upper and lower ends of each guide strap shoes are fastened to the frame